A DECISION-MAKING FRAMEWORK TO FACILITATE COST SAVINGS AND MITIGATE ENVIRONMENTAL IMPACTS IN THE COAL MINING INDUSTRY

by

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ABSTRACT

Emalahleni, situated in Mpumalanga Province in South Africa, has been exposed to over a hundred years of continuous mining of coal. Evident challenges include the sterilisation of land due to underground fires, polluted water, surface collapse and acidification of topsoil (McCarthy & Pretorius, 2009:65; Schneider, 2016:1). The researcher reviewed existing literature to determine existing frameworks thereby identifying gaps. Consequently, the researcher found no published decision-making framework that may assist coal mining companies in South Africa to preserve the environment and its natural resources. Research objectives and research questions as well as a preliminary framework were developed. A qualitative research design was adopted in which personal interviews were employed to gather primary data from coal mining companies in South Africa whilst a focus group was utilised to validate the framework. Personal interviews established that majority of participants were not familiar with EMA and that EMA tools such as ISO, LCC and the green strategy would add value to the coal mining industry. Furthermore, there was no consistency in the application and adherence to environmental regulations. Participants also indicated that current processes employed by the coal mining industry were not effective in saving the environment. In validating the framework, the focus group established that tools (methodologies) will serve the purpose as indicated in the framework and that the framework was relevant to the coal mining industry. There was a general consensus that regulatory aspects can go a long way in controlling adverse effects on the environment, so long as these would be applied to all industries, and not only the coal mining industry. Input from the focus group assisted in enhancing the framework by testing the associations and links. Key recommendations indicated that coal mining companies should incorporate environmental accountability in their corporate decisions; education and training should be conducted in all coal mining companies in order for these companies to know the type of information that they need to utilise in identifying waste. Future research could include a similar study of statistical nature that will test the decision-making framework developed in this study. Going to the coal mining companies to exercise the framework on a real-life setting.

Keywords: Coal mining, Cost savings, Decision-making, Environment, Environmental Management Accounting, Decision-making framework

MANWELEDZO

Emalahleni, hu wanala kha Vundu ḽa Mpumalanga Afrika Tshipembe, ho ṱanea lwa miṅwaha i fhiraho ḓana nga migodi ya malasha ine ya khou bvela phanḓa. Khaedu dze dza vhonala dzi katela, nyiledzo ya mavu zwo vhangwa nga mililo ine ya thoma fhasi migodini, maḓi o tshikafhadzwaho, u wa ha nyalo na esidi kha mavu a nṱha. (McCarthy & Pretorius, 2009:65; Schneider, 2016:1). 65; Muṱoḓisisi vho sedzulusa hafhu maṅwalwa ane a vha hone u topola furemiweke dzi re hone, nga u topola zwikhala. Muṱoḓisisi a vho ngo wana furemiweke yo ganḓiswaho ya tsheo yo dzhiwaho ganḓiswaho ine ya nga thusa khamphani dza migodi ya malasha Afrika Tshipembe u vhulunga vhupo na zwiko zwadzo zwa mupo. Zwipikwa zwa ṱhoḓisiso na mbudziso dza ṱhoḓisiso na furemiweke thangeli zwo bveledziswa. Ho shumiswa ngona ya kuitele kwa ṱhoḓisiso kwa khwaḽithethivi he ha shumiswa inthaviwu dza vhuṋe u kuvhanganya data kha vhathu u bva kha khamphani dza migodini ya malasha Afrika Tshipembe ngeno tshigwada tsho sedzwaho khatsho tsho shumisiwa u khwaṱhisedza furemiweke.

Inthaviwu dza vhuṋe dzo sumbedzisa uri vhunzhi ha vhadzheneleli vho vha vha sa ḓivhi zwishumiswa zwa EMA na zwa EMA zwi nga ho sa ISO, LCCP na muṱalukanyo une wa dzhiela nṱha mveledziso ya matshilisano na mveledzwa dza vhupo zwi ḓo engedza ndeme ya nḓowetshumo ya migodi. Zwi tshi ya phanḓa, a hu na u tevhekana ha zwithu kha kushumisele na u tevhedza ndaulo dza vhupo. Vhadzheneleli vho dovha vha sumbedzisa uri maitele a zwino o shumiswaho nga nḓowetshumo ya migodi ya malasha o vha i si khou u shuma kha u vhulunga vhupo. Kha u khwaṱhisedza furemiweke, tshigwada tsho sedzwaho khatsho tsho bveledza uri zwishumiswa (ngona) dzi ḓo thusa kha ndivho sa zwo sumbedzwaho kha furemiweke na uri furemiweke yo tea kha nḓowetshumo ya mugodi wa malasha.

Hu na thendelano nyangaredzi uri zwiteṅwa zwa ndaulo zwi nga ya kule u langula masiandaitwa kha vhupo, tenda hezwi zwa shumiswa kha nḓowetshumo dzoṱhe, hu si fhedzi kha nḓowetshumo ya migodi ya malasha. Muhumbulo u bva kha tshigwada tsho sedzwaho khatsho wo thusa kha u khwinisa furemiweke nga u linga vhuṱumani na vhushaka. Themendelo khulwane dzo sumbedzisa uri khamphani dza migodi ya malasha dzi fanela u dzhenisa vhuḓifhinduleli ha vhupo kha tsheo dzayo dza bindu; hu fanela u farwa vhugudisi na pfunzo kha khamphani dzoṱhe dza migodi ya malasha uri khamphani idzi dzi ḓivhe lushaka lwa mafhungo ane vha tea u a shumisa kha u

topola malaṱwa. Ṱhoḓisiso dza tshifhingani tshiḓaho dzi nga katela ngudo i fanaho ya nḓila ya zwitatisiṱika ine ya ḓo linga furemiweke ya u dzhia tsheo yo bveledziswaho kha ngudo iyi. Hezwi zwi do katela u ya kha khamphani dza migodi ya malasha u ita tsedzuluso ya furemiweke kha nyimele ya vhukuma.

Maipfi a ndeme: Mugodi wa malasha, Mutengo wa u vhulunga, U dzhia tsheo**,** Vhuḓifhinduleli ha Ndangulo ya Mupo, Furemiweke ya u dzhia tsheo

OPSOMMING

Steenkool word langer as honderd jaar ononderbroke om Emalahleni in Mpumalanga ontgin. As gevolg hiervan raak grond steriel weens ondergrondse brande, word water besoedel, sak die grondoppervlak in en versuur die bogrond. In die literatuur kon die navorser kon geen besluitnemingsraamwerk waarvolgens Suid-Afrikaanse steenkoolmaatskappye die omgewing en natuurlike hulpbronne bewaar, vind nie. Navorsingsdoelwitte is gestel, en navorsingsvrae en ’n voorlopige raamwerk is opgestel. ’n Kwalitatiewe navorsingsontwerp is gevolg en persoonlike onderhoude is by Suid-Afrikaanse steenkoolmaatskappye gevoer om die primêre data te versamel. Die geldigheid van die besluitnemingsraamwerk is met ’n fokusgroep getoets. Uit die persoonlike onderhoude het geblyk dat die meeste deelnemers onbekend was met omgewingsbestuuraanspreeklikheid (OBA) en dat hulle nie geweet het dat hulpmiddels soos ISO, ’n lewensikluskosteberekening (LSK) en ’n groen strategie waarde tot die steenkoolbedryf kan toevoeg nie. Afgesien hiervan is omgewingsregulasies nie eenvormig toegepas en nagekom nie. Deelnemers het eweneens laat blyk dat die steenkoolbedryf se huidige prosesse gemik op omgewingsbewaring oneffektief is. Die fokusgroep het vasgestel dat die hulpmiddels (metodologieë) die oogmerk van die raamwerk verwesenlik, en die raamwerk dus geldig en van groot nut vir die steenkoolbedryf kan wees. Daar was eenstemmigheid dat die regulerende aspekte die nadelige uitwerking van mynbouwerksaamhede op die omgewing kon beheer, op voorwaarde dat dit nie alleen in die steenkoolbedryf nie, maar in alle bedrywe toegepas word. Die raamwerk is aan die hand van die fokusgroep se insette verfyn deur die verbande en skakels te toets. Die belangrikste aanbevelings behels dat omgewingsaanspreeklikheid deel van steenkoolmaatskappye se besluitneming moet uitmaak, en dat alle steenkoolmaatskappye opgelei moet word in die soort inligting waarvolgens bepaal word wat afval is. In die toekoms kan ’n soortgelyke statistiese studie onderneem word om die besluitnemingsraamwerk wat in hierdie studie ontwikkel is, te toets. Dit sal behels dat die raamwerk in lewensegte omstandighede by steenkoolmaatskappye ondersoek word.

Kernbegrippe: Steenkoolbedryf, Kostebesparings, Besluitneming, Omgewing, Omgewingsbestuuraanspreeklikheid, Besluitnemingsraamwerk

DECLARATION

Student No: 72224134

I, Mashudu David Mbedzi, declare that **A decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry** *is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.*

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

02 February 2020

SIGNATURE **DATE**

DEDICATION

This success is dedicated to my late parents, Mrs. Thambulo Mbedzi (Miya Tsemano), for being resourceful in raising us with very limited resources and for teaching us to be God-fearing. Mr. Mulevhuwe 'Skhada' Mbedzi for raising us to be respectful, down to earth and hardworking humans. To my late sisters, Gladys, Elizabeth, you did well. To the late Advocate Stephen Petla and Mr. Liketso Moyo, I wish you were here to witness my achievement. To my late Hounourable Father in law, Mr. Elijah Ndaba, thank you for giving me a wonderful wife (s) and for your love. This is for you.

To the remaining pillar and mother in law, Mrs. Maria-Mathunzi Ndaba and friend (Mam Annah Shongwe), this is for you and thank you for the prayers. This success is dedicated to my family, brothers and sisters as well as friends who believed in me. To my wonderful wife Thandi (Shorty) and Gugu Ndaba (Twin), this is for you. My dearest brother Fhumulani and Sindiswa Moyo, Ezekiel, Godfrey and Eunice Mbedzi, Tsemano Khumalo this is for you. Dr. Vhulahani Tshikota and Dr. Motladi Angeline Setlhako this one is for you.

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"I thank God in Jesus Christ for having mercy on me. It has been a long road, but you never left me."

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- To Ms. Mmadire Kotu-Rammopo, thank you “Mummy”.

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ABC	Activity Based Accounting
AIJ	Activities Implemented Jointly
AMD	Acid Mine Drainage
BSCs	Balance Score Cards
BEN	Balkan Endemic Nephropathy
COPD	Chronic Obstructive Pulmonary Disease
CCP	Content, Context and Process
CKD	Chronic Kidney Disease
CP	Cleaner Production
DEA	Department of Environmental Affairs
DME	Department of Minerals and Energy
DNA	Deoxyribonucleic Acid
DSD	Division of Sustainable Development
DWARF	Department of Water Affairs and Forestry
ECA	Environmental Cost Accounting
EMSs	Environmental Management Systems
EIA	Environmental Impact Assessment
EFA	Environmental Financial Accounting
EMA	Environmental Management Accounting
EMAF	Environmental Management Framework
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPE	Environmental Performance Evaluation
EPI	Environmental Performance Indicator
ESV	Environmental Shareholder Value
EU	European Union
ERP	Enterprise Resource Planning
GC O_2/km	Carbon Dioxide emissions From a Car per Kilometre
ISO	International Organisation for Standardisation
KWh	Total energy in kilowatt-hours
LCA	Life Cycle Analysis
LCC	Life Cycle Costing

MFA	Material Flow Analysis
MFCA	Material Flow Cost Accounting
MCS	Management Control Systems
MEMA	Monetary Environmental Management Accounting
MISs	Management Information System (s)
MKB	Main Karoo Basin
MPRDA	Mineral and Petroleum Resources Development Act
Mt	Million Tonnes
NEMA	National Environmental Management Act
NGOs	Non-Governmental Organisations
NIMBY	Not-In-My-Back-Yard
NPO	Non-Product Output
NPV	Net Present Value
NRBV	Natural Resource Based View
NSW	New South Wales
PAHs	Polycyclic Aromatic Hydrocarbons
PEMA	Physical Management Accounting
PPP	Polluter-Pays-Principle
RBV	Resource Based View
SC	Supply Chain
SCC	Sustainable Cost Calculation
SD	Sustainable Development
SLO	Social License to Operate
SM	Sustainability Mining
SO_2	Sulphur Dioxide
TCA	Total Cost Assessment
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNDSD	United Nations Division of Sustainable Development
VOC	Volatile Organic Compounds
ZIMRA	Zimbabwean Revenue Authority

CHAPTER 1: BACKGROUND OF THE STUDY

1.1. INTRODUCTION

Coal has played a significant role for the past 100 years by providing electricity to households and companies, thereby playing a socio-economic role in South Africa. The usage of coal started as early as 1923 when it replaced hydropower as a major source of energy. However, the use of coal in power plants produces emissions in the form of smoke which affects humans as well as fauna and flora. It contributes considerably to the gross domestic product (GDP) (Mathu & Chinomona, 2013:347). Coal deposits in South Africa are in what is referred to as the Karoo Super group. This is a dense categorisation of alluvial rocks that were deposited during a period ranging from 180 to 300 million years. These coal layers are found in the segment known as the Ecca subgroup, made up of mudstones including sandstones. The coal deposits that were deposited in large river locations appropriate for the development of coal did not occur in all places, and these coal deposits are limited, mostly befalling in the basin of the Karoo (McCarthy & Pretorius, 2009:65). The stretch of the basin ranges from Welkom in the Free State province to Nongoma in Kwa-Zulu Natal. It is projected that about 50% of the coalfields in areas such as Emalahleni, Ermelo, and Highveld encompass the deposits of coal that may be recovered (Bordy, Hancox & Rubidge, 2004:392).

It is evident from the Mineral Council of South Africa (2020:1) that the coal industry employed 92,230 people in 2019 (86,647 in 2018), representing about 19% of total employment in the mining sector. 258.9 million tonnes (Mt) produced in 2019 (253 Mt in 2018) with total coal sales of R139.3 billion (R146 billion in 2018). Net investment in the coal industry was R4.5 billion in 2010, decreasing to R2.5 billion in 2018 - an average decline of 15% per year. This is despite the fact that coal is a major source of electricity in the country. The Mineral Council of South Africa (2020:1) indicates that the coal industry spent R61 billion in procuring goods and services, most of it locally, therefore contributing to the creation and maintaining of jobs in other industries. 70% of the coal volume is consumed domestically and more than 70% of electricity demand is generated from coal power. Richards Bay coal terminal (RBCT) serves as the primary export port and has a dedicated rail line.

The observation by Eberhard (2011:1) shows that the coal mining industry in South Africa contributes much to the country's economic welfare and offers profitable investment opportunities, yet brings about several challenges, for example environmental impacts and compromising the health of humans. By far the most severe problem is the rise in the contamination of water. For instance, water in one of the South African provinces, Mpumalanga, where the Middelburg dam is situated, is estimated to be 40% unsuitable for human consumption (Eberhard, 2011:1). The critical challenge facing South Africa is to propose and provide policies and frameworks that are effective and integrated to assist mining companies to make informed decisions about their effects on the environment. Moreover, resolute capital approaches should be employed to generate foreign capital inflows and platforms that ought to mitigate the problems caused by mining activities. This will ensure that South Africa as a country is aligned to sustainable improvement whilst taking full advantage of the prospective export profits through the export of coal (Eberhard, 2011:1).

To mitigate the preceding challenges within the coal mining industry in South Africa, this thesis provides interplay between coal mining and environmental management accounting (EMA). EMA refers to the accounting information requirements of management of different departmental undertakings affecting the environment and related environmental impacts (Ntalamia, 2017:2). Currently, managers and researchers have started adopting and implementing EMA processes as a way of integrating complete environmental information into daily operational activities. Nevertheless, the execution of EMA within companies is lagging and most challenges relate to conceptual and practical challenges in assimilating environmental information as well as providing guidance on effective application thereof (Derchi, Burkert & Oyon, 2013:197).

The South African Karoo and Ecca subgroup coal deposits map is shown in Figure 1.1.

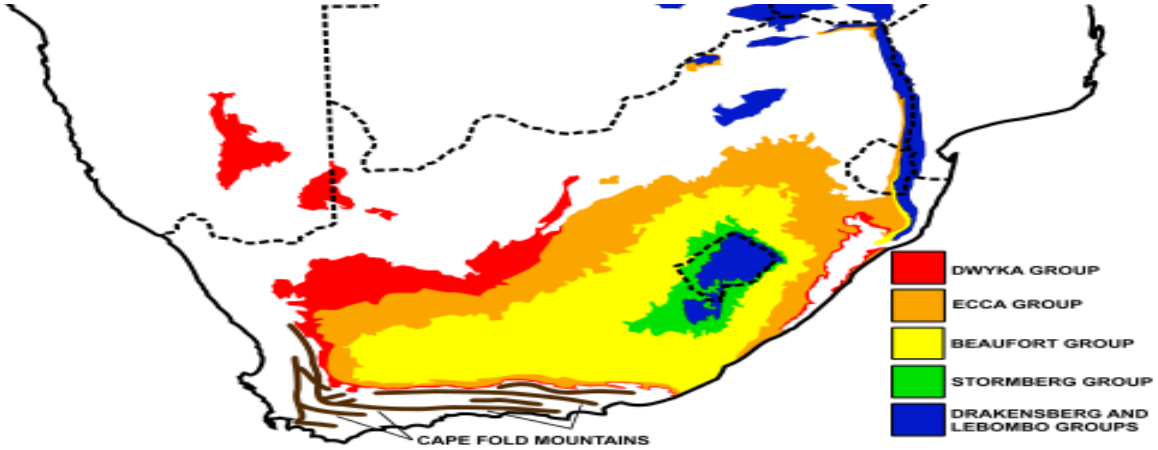

Figure 1.1: The South African Karoo and Ecca subgroup coal deposits

Source: *Anhausser and Maske (1986)*

As demonstrated in Figure 1.1, all the coalfields of South Africa occur in rocks of the main Karoo basin (MKB) and its associated sub-basins. This is since much new work has been undertaken in the past decade to understand the tectonics and sedimentary fill of these repositories, therefore, a brief overview of Karoo aged depocenters of South Africa is critical.

1.1.1. Goal of Chapter 1

The goal of this chapter is to provide the background to the study, the problem to be researched, indicate the problem statement, and define the research questions and objectives. Furthermore, to indicate the significance of the study, the research methodology and ethical considerations as well as the structure of the thesis will be addressed.

1.1.2. Layout of Chapter 1

The layout of the chapter is as follows: In Section 1.2, the background to the problem is discussed and is followed by Section 1.3 defining the problem statement. Section 1.4 portrays the research aim, Section 1.5 states the research questions, and Section 1.6 defines the research objectives. Section 1.7 follows with a discussion of the research methodology. In Section 1.8 the trustworthiness of the study is considered. Section 1.9 discusses the ethical considerations and Section 1.10 portrays the significance of the study. Section 1.11 presents the structure of the thesis.

Section 1.12 presents the definitions, and the chapter concludes with a summary in Section 1.13.

1.2. BACKGROUND TO THE PROBLEM

Stemming from Zurich (2019:1), the assertion by Woo (2007:593) demonstrates that China's environmental degradation due to coal mining is exceptional. The extent of air pollution within households and the external environment is projected to kill 656,000 Chinese citizens annually. Almost one-fifth of China's agricultural land is polluted. The country is highly exposed to high levels of desertification and soil erosion, with about 30% of China's land affected by desertification and 37% by soil erosion. It is also estimated that 320 million people in China do not have clean water to drink. There has been a rise in environmental pollution due to the country's industrial activities (Xinhua, 2014:1).

The view by Parwada and van Tol (2016:544) shows that soil erosion is a major land degradation problem in South Africa (SA) that has economic, social and environmental implications due to both on-site and off-site effects. High rates of soil erosion by water are causing rapid sedimentation of water bodies, ultimately leading to water crisis in SA. Moreover, Parwada and van Tol (2016:544) argue that lots of financial and human resources are channelled towards controlling of soil erosion but unfortunately with little success. The level of soil erosion in a particular area is governed by the site properties.

The mining process generates large quantities of waste that must be correctly treated and managed to combine economic efficiency with demands for environmental sustainability, human health risks as well as demands on water resources. Hence, the required technology ought to be taken into consideration. The waste generated by mineral extraction may be solid, tailings or slurry, with the most common being tailings, waste rock, slag and tail ends (Cebada & Diego, 2016:78).

McCarthy and Humphries (2013:1) emphasised that South Africa has large coal reserves. It is regarded as the sixth largest coal-producing country and the fifth largest exporter of coal globally. Therefore, it plays a significant role in the South African economy, with nearly 93% (McCarthy & Humphries, 2013:1) of the country's electricity produced by coal-fired power stations Nevertheless, coal mining contributes to the migration of people as they move to seek employment in various provinces in South Africa and impacts on their health. For instance, coalmine methane gas released

during and after the coal mining activities causes underground gas explosions. Opencast mining is destructive as it removes huge quantities of topsoil and rock to reach the workable coal deposits thereby destroying provincial aquifers. However, Munnik (2010:3) established that coal heaps are prone to spontaneous combustion. Leachate from waste heaps are often acidic leading to acid mine drainage (AMD) which pollutes underground and surface water. This argument is validated by Feris and Kotzé (2014:2105) who observed that AMD is reported to have polluted most of the South African water resources.

Nkambule and Blignaut (2012:85) assert that in the absence of appropriate substitutes to coal in South Africa, coal is still likely to be used in the upcoming decades. Although it remains a reliable source of energy, it has unquestionably caused great damage to socio-economic and ecological activities of the host communities due to emissions. Eberhard (2011:1) suggests that the South African coal industry provides both challenges and opportunities. Therefore, the key challenge for South Africa as a country is to come up with integrated strategic policies and governing programmes to facilitate cost savings and reduce the impact on the environment, and furthermore, to devise and implement meaningful investment approaches and programmes that might position the country on a sustainable growth path whilst taking full advantage of possible export profits.

1.3. PROBLEM STATEMENT

Challenges with the effects of the coal mining industry on the environment are particularly prevalent in Southern African developing countries. Familiarity with the situation at the Emalahleni area that has been exposed to over a hundred years of continuous mining of coal provides awareness into what the imminent repercussions might hold. Shareholders benefit from the revenue generated by the sale of the extracted coal from the coalmines; however, these companies should also account for the environment in which they operate. Complications that have occurred include the sterilisation of land due to underground fires, fruitless restoration measures, surface collapse and acidification of topsoil (McCarthy & Pretorius, 2009:65). Similar impacts such as polluted water, deformed landscapes, and acidic red water were noted in Vryheid in the Kwa-Zulu Natal (KZN) Province. This is due to the derelict mines that were closed when coal mining ceased in KZN in the 1990s (Schneider, 2016:1)

Therefore, water quality and supply has become a national crisis. Moreover, little is being done to curb the pollution and poisoning of water sources or wastage (Watson, 2019:1; Du, Dinçer, Ersin & Yüksel, 2020:1).

Having reviewed existing literature, the researcher identified the absence of a framework (referred to in this thesis as a decision-making framework) to facilitate cost savings and make informed decisions to mitigate above-mentioned environmental impacts, specifically for the coal mining industry.

1.4. RESEARCH AIM

The goal of this study is to find answers to the research questions and in the process develop a decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry of developing countries.

1.5. RESEARCH QUESTIONS

Following the above discussion and problem statement, this study intends to address the following research questions with respect to the coal mining industry in developing countries:

- What information is used in the coal mining industry to make decisions regarding their impact on the environment?
- Which information does the coal mining industry need to identify waste?
- Which information does the coal mining industry need to minimise costs regarding their impact on the environment?
- How successful are the existing processes employed by the coal mining industry to make decisions on their environmental impact and related cost savings?
- What are the benefits of EMA for the coal mining industry?
- What are the reasons for possible non-implementation of EMA principles and associated management accounting tools by the coal mining industry?
- Which processes ought to be followed by the coal mining industry to make decisions on their environmental impact and related cost savings?

This research intends to address the above questions thereby fulfilling the purpose of this study.

1.6. RESEARCH OBJECTIVES

The aim of this study will be addressed through the following objectives that is to:

- Determine the information that the coal mining industry is using to make decisions regarding their impact on the environment.
- Establish the information needed by the coal mining industry to identify waste.
- Define the information to be used by the coal mining industry to reduce costs regarding their impact on the environment.
- Establish how effective existing processes employed by the coal mining industry are to facilitate decisions on environmental impact and related cost savings.
- Assess the benefits of EMA for the coal mining industry.
- Determine the reasons for possible non-implementation of EMA principles and tools by the coal mining industry.
- Determine the processes that ought to be followed by the coal mining industry to effect cost savings and minimise environmental impact.
- Develop a decision-making framework to facilitate cost savings and waste of the environmental impacts in the coal mining industry of developing countries.

1.7. RESEARCH METHODOLOGY

The previous section indicated the background to the study, problem statement, research aim, research questions and research objectives. This section clarifies the methodology that was used to address the objective of the study. A broad literature review informed the research instruments. The researcher personally engaged the coal mining sector to acquire primary data from the participants. To eliminate bias, three (3) qualitative research techniques of data collection, namely, an extensive literature review, personal interviews, and a focus group to theoretically test the framework developed, were applied. Figure 1.2 depicts the triangulation approach that was utilised in this research.

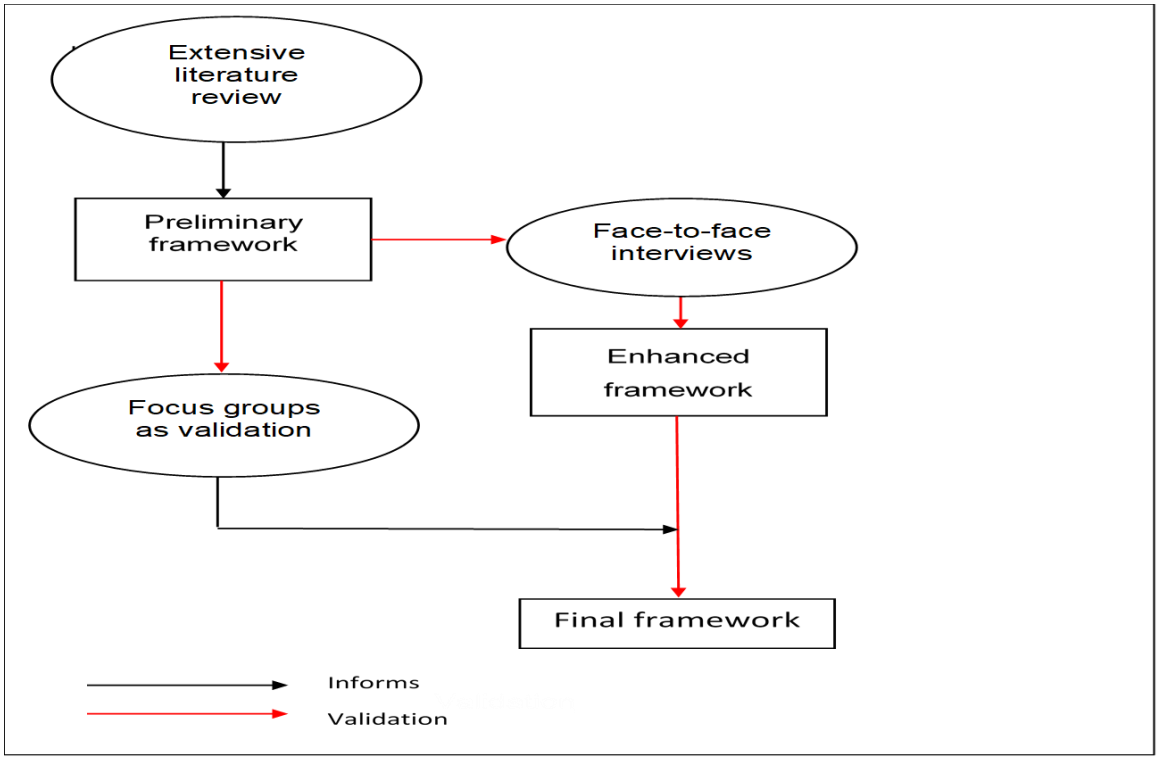

Figure 1.2: Triangulation process

Source: *Researcher's own construct*

The triangulation approach minimised bias in the sense that each of the three techniques has its own distinct advantages. Figure 1.2 demonstrates that reviewed literature and face-to-face interviews informed the development of a preliminary framework. This framework further informed the focus group as validation of the preliminary framework to come up with an enhanced final framework. The extensive literature review led to the identification of propositions and the development of the research instruments. The face-to-face interviews provided a platform whereby the researcher personally engaged the participants. This enabled the researcher to source primary data from the interviewees who were directly linked to coal mining activities at the time of the interview. On the one hand, the focus group sessions provided an environment that allowed participants to influence or to disagree with each other's views (Salkind, 2018:215). Focus groups are usually characterised by a non-directive style of interviewing. The main objective is to promote an extensive array of views on the discussion in the focus group (Wagner, Kawulich & Garner, 2012:27).

A preliminary framework was developed through an extensive review of scholarly literature and face-to-face interviews. Personal interviews enabled the researcher to

create a relationship and understanding with the prospective participants thereby getting collaboration. To validate the framework, the researcher approached Coaltech, which is a research institute that manages and coordinates a group of coal mining companies. Permission was granted for the researcher to present the framework to seven coal mining companies who were part of the focus group session.

The researcher requested their input and advice from participants in the focus group. The acquired data was used to enhance the preliminary framework that is presented at the end of Chapter 5.

1.7.1. Research design

A qualitative research design was chosen for this study. It implies a structure for collecting and analysing data. It is like an architectural blueprint that is followed in the construction of a building. For instance, specifying what material is required, how much of it will need to be sourced and the layout of the building (Wagner *et al*., 2012:21). Therefore, this study applied an inductive research approach to collect data through personal interviews and a deductive approach through the validation of a framework.

1.7.2. Selection of the study area

This study focussed on the South African coal mining sector. Eberhard (2011:5) asserted that most of the coal deposits in South Africa are in the South African Highveld, that is: Emalahleni, the Ermelo area, and Lephalale in Limpopo.

1.7.3. Purposive sampling

With purposive sampling, the researcher uses judgement to select cases that will answer the research questions and to address the research objectives. Purposive sampling is also known as judgemental sampling (Saunders, Lewis & Thornhill, 2016:301). In purposive sampling, people or other units are chosen as the name implies for a specific purpose (Leedy & Ormrod, 2015:183). Therefore, 50% of all coal mining companies in South Africa were purposively selected for this study as the targeted coal mining companies were known by the researcher.

1.7.3.1. Composition of the sample

The sample was composed of all levels of employees within the coal mines in South Africa. These ranged from Supervisors, Senior Managers, General Managers, Chief Executive Officers (CEOs), and employees on the ground from various coal mining companies.

1.7.4. Data collection and methods

During the personal interviews, and focus group session, the researcher took notes and used a digital recorder. The face-to-face interviews may produce an abundant set of useful primary data. Considering ethical considerations, permission was requested from the mining companies. Permission letters also accompanied the participant information sheets as advised by Leedy and Ormrod (2015:160).

Consent forms were given to the participants prior to the interviews and focus group. All participants signed the consent forms; therefore, agreeing to participate in the study through personal interviews and a focus group. Different questions were asked for the personal interviews and focus group session in order to assess responses from both personal interviews and the focus group sessions. This means that there were two research instruments, one for the focus group and the other for the personal interviews. Questions for the personal interviews sought to validate the content of the entities whilst questions posed in the focus group intended to validate the associations among the entities (Appendix A).

1.7.5. Data analysis and techniques

The researcher used a thematic analysis to analyse data that was collected through face-to-face interviews as well as a focus group. In qualitative research, a code implies a word or short expression, which figuratively assigns a complete, substantial or suggestive characteristic for a specific language-based data. In NVivo coding is possibly the most well-known and most commonly used qualitative coding method. It uses phrases or short expressions from the partaker's own dialect truths as a code. It may include general or indigenous terms of a certain cultural, subcultural, or micro cultural being of the cluster's social groups, for instance, code blue, sharps, and scripts (Saldaña, 2009:74; Salkind, 2018:159). Data gathered through personal interviews

and a focus group session will be analysed as per Creswell's (2012:179) data analysis spiral process. The process of organising and analysing data is discussed in detail in the following section.

1.8. TRUSTWORTHINESS

In the following sub-sections, trustworthiness, credibility, dependability, confirmability, transferability and authenticity of the study are discussed.

1.8.1. Internal trustworthiness

During the triangulation approach, that is, the extensive literature review, personal interviews and a focus group permitted the researcher to draw correct and unprejudiced deductions for this research. This offered the researcher assurance that the inferences made were justified based on the data that was gathered as proclaimed (Leedy & Ormrod, 2015:336).

1.8.2. External trustworthiness

The fact that the researcher made sure that the sampling was representative of all coal mining companies in South Africa, the research findings should be generalisable to the coal mining industry in developing countries such as Africa by considering the similarities of the coal mining trends. Furthermore, the focus group as theoretical validation ensured that participants provided independent and objective views (Leedy & Ormrod, 2015:336).

1.8.3. Authenticity

Research is considered authentic if it is a fair illustration of that which it signifies to be and when there is no concealed agenda linked to it. For the credibility of a qualitative research study, it is critical that all participants are perceived to be able to provide an authentic account of their experiences (Remenyi, 2014:12). In establishing authenticity, the researcher targeted participants from the coal mining industry who were able to provide primary data based on their experiences.

1.8.4. Confirmability

Confirmability implies the extent to which others agree or corroborate with the findings of the study (Leedy & Ormrod, 2015:336). This study is unique; the researcher rechecked and verified the data collected through the theoretical validation of the framework. Furthermore, negative instances that contradict previous interpretations may be uncovered. The researcher also referred to earlier studies of a similar sample in the coal mining industry.

1.8.5. Credibility

The researcher sourced primary data through personal interviews from participants who are directly involved in coal mining operations (at the time of research.) These, together with the triangulation approach utilised in this research, offered the study credibility. The data gathered from the personal interviews and the focus group as validation of the framework linked to the reviewed literature were discussed to draw conclusions and recommendations. Wagner *et al*. (2012:376) suggested that credibility implies the quality of a research report that was conducted based on the principles of good practice.

1.8.6. Dependability

Dependability in qualitative research implies the degree to which the data is constant over a certain period including circumstances, and it can be equated to reliability in quantitative research. In ensuring dependability, the researcher evaluated the value of the assimilated procedures of assembling of records and philosophical generation (Wagner *et al*., 2012:376).

1.8.7. Transferability

Since this study is of a qualitative nature, it does not necessitate external validity in that every study is distinctive as well as various settings. However, the transferability of this research is the ability to generalise or the degree to which the outcomes of this research might apply to related contexts or settings.

1.9. ETHICAL CONSIDERATIONS

The foregoing section indicated the relevant methodology that was employed in this study; hence, this section discusses ethical issues thereof. When humans or animals are targeted by the study, researchers must take ethical issues into consideration. Therefore, the researcher considered the following ethical guidelines:

- **Protection from harm:** the researcher provided respondents with a participant information sheet affirming that the individual particulars of the participants would by no means be divulged for the duration of or after the duration of the research. Leedy and Ormrod (2015:120) advised that human and non-human animals should not be subjected to any physical or psychological harm when they are involved in research.
- **Informed consent:** the researcher provided the participants with consent forms which were signed by partakers before participating in the research. The consent forms indicated that the participants had a right to take part or not to take part in this research. Furthermore, participants had the right to withdraw at any stage of this research. Saunders, Lewis and Thornhill (2016:244) suggested that researchers must provide participants with ample information and assurances regarding the nature and implications of the research.
- **Right to privacy:** the researcher informed the participants in writing that their individual information would not be revealed during or after the duration of the study. Furthermore, fictitious names were utilised in compiling the thesis. This was to protect the identity of the partakers (Leedy & Ormrod, 2015:123).
- **Honesty with professional colleagues:** the researcher reported the findings of this study in a comprehensive and truthful manner, without distorting or deliberately misrepresenting the readers of this research. Leedy and Ormrod (2015:123) implored that researchers should present their findings in a complete and honest manner without any misrepresentation of what transpired.
- **Permission to conduct research:** the researcher requested permission to conduct the study from the executives of the targeted coal mining companies in South Africa. Written permission was given to the researcher and this allowed for the collecting of data to proceed. Ethical clearance was sought and received from the SBL's Ethics Committee (Leedy & Ormrod, 2015:123).

1.10. LITERATURE REVIEW

Familiarity with the situation at the Emalahleni area that has been exposed to over a hundred years of continuous mining of coal creates an awareness of what the imminent repercussions might be. Shareholders benefit from the revenue generated by the sale of the extracted coal from the mines (McCarthy & Pretorius, 2009:65). However, companies should also account for the environment in which they operate. Complications that have occurred comprise the sterilisation of the land due to underground fires, fruitless restoration measures, surface collapse and acidification of topsoil (Shongwe, 2018:1).

Whilst minerals such as gold have played a critical part in the growth of the South African economy, it was in fact coal which provided power to the mining of gold with many power stations situated around Emalahleni. As a result, the coal mining provinces, especially the Mpumalanga region, play a critical role in uplifting the South African economy (Campbell, Nel & Mphambukeli, 2017:225).

Figure 1.3 depicts the location of coal deposits in South Africa.

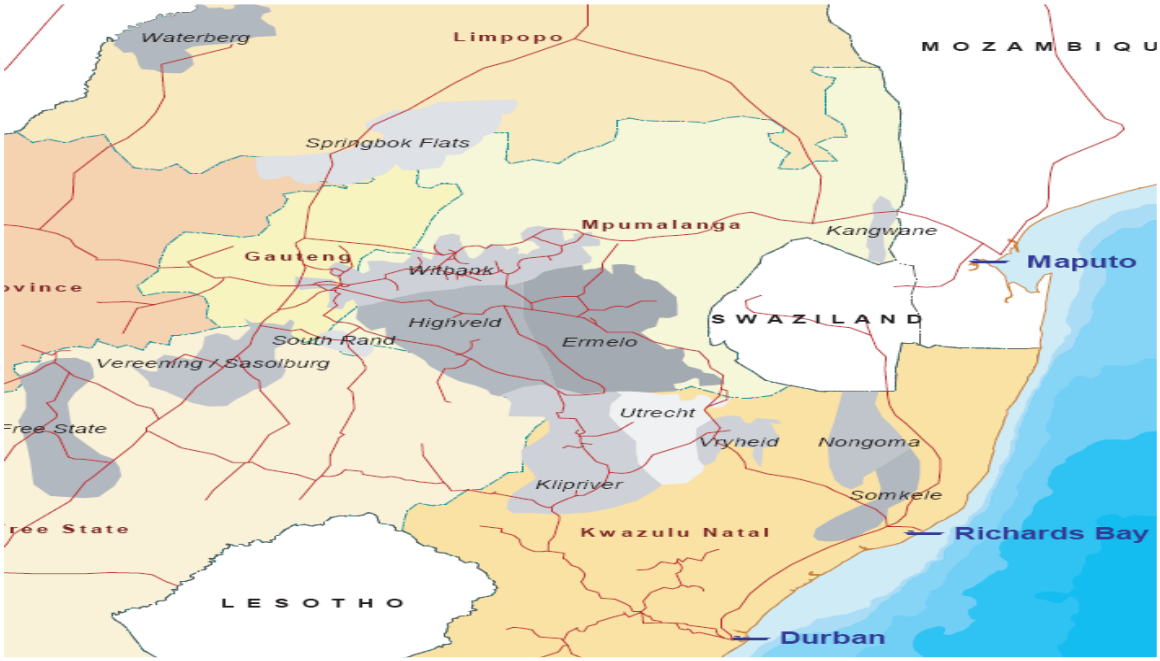

Figure 1.3: Coal deposits in South Africa

Source: *Eberhard (2011:20)*

Figure 1.3 demonstrates the significance and locality of most of the coal deposits in South Africa located in Mpumalanga in areas such as the Highveld, Emalahleni and

Ermelo. Other coal deposits are located on the far north at the Waterberg area; however, these are at a small scale compared to the Mpumalanga area (Eberhard, 2011:7).

1.11. SIGNIFICANCE OF THE STUDY

The researcher postulates that the development for a decision-making framework will assist all companies in South Africa and the developing world to take informed decisions, assess the efficiency of their operational process to determine their impact on the environment as well as their productivity thereof. Moreover, EMA tools such as material flow cost accounting (MFCA) and life cycle costing (LCC) can be used by coal mining companies to identify waste in the production process and to determine investment opportunities. Recommendations will assist the South African government in developing effective policies and to determine the level of enforcement of environmental legislation within the coal mining industry including other industries. This study will serve as a benchmark and will also benefit academia as it will add value to the body of knowledge internationally from the South African perspective.

1.12. STRUCTURE OF THE THESIS

Chapter 1 provides the background to the study in terms of the problem statement, research objectives and research questions, the research methodology, scope of the study, and definitions of the study.

Chapter 2 reviews existing literature by looking at the theoretical/conceptual framework limited to the research topic.

Chapter 3 demonstrates the research methodology that was employed in this study.

Chapter 4 addresses the aim of this research, which was to develop a decision-making framework to facilitate cost savings of environmental impacts in the coal mining industry.

Chapter 5 presents the findings of the study starting with biographical profile of those who participated in this research.

Chapter 6 validates the framework developed in the preceding parts of the thesis.

Chapter 7 provides conclusions, recommendations, and suggestions for future research.

1.13. DEFINITIONS USED IN THE STUDY

In this section, key definitions of this study are discussed.

Environmental Management Accounting (EMA) refers the identification, collection, analysis and the use of two types of information for internal decision making. This includes physical information on the use, flows and destinies of energy, water and materials (and wastes); as well as financial information relating to environmental costs and profits (Burritt & Saka, 2006:1262; Vasile & Man, 2012: 566).

Physical EMA (PEMA) includes the movement of water and energy (Schaltegger, Hahn & Burritt, 2000:18).

Monetary EMA (MEMA) measures the costs of the company's exploitation of natural capital and the overheads for managing or avoidance of environmental damages (Tsui, 2014:3).

Material Flow Cost Accounting (MFCA) quantifies the movements and inventory of materials in processes or production lines in both physical and financial components (Tachikawa, 2014:1; Nakajima, Kimura & Wagner, 2015:1303).

Activity-based costing (ABC) is a management accounting technique which categorises the activities that a company accomplishes and assigns indirect costs to products (IFAC, 2005:27; Al-Halabi & Shaqqour, 2018:262).

1.14. DEMARCATION OF RESEARCH

This study will cover coal mining industry and will exclude other mining industries such as gold, chrome, manganese etc. However, reference will be made on the application of the framework to other industries.

1.15. SUMMARY

In this chapter, the background of the study, background to the research problem, significance of the study, research questions, research aim and objectives, problem

statement and structure of the thesis were clarified. The next chapter reviews literature limited to the research topic of the study.

CHAPTER 2 – LITERATURE REVIEW

2.1. INTRODUCTION

In the previous chapter, the background of the study was explored, and it was established that the coal deposits in South Africa are situated in the Karoo Super group. Mining companies were identified as polluters of the environment and the need for information to cut down on cost and to save the environment was identified. The problem statement, research aim, research questions, and research objectives were clarified. The internal and external trustworthiness, credibility, dependability, confirmability, transferability, and authenticity of the study were indicated. Moreover, ethical considerations, significance of the study, and structure of the thesis were illustrated.

2.1.1. Goal of Chapter 2

The goal of Chapter 2 is to review literature relevant to the research topic to develop a decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry. Consequently, this chapter reviews existing literature to address the research objectives of the study. The literature review is structured in such a way that it links the key concepts reflected in the enhanced framework as presented at the end of Chapter 5. These key concepts include the impact of coal mining on the natural environment; a conceptual framework for coal mining operations and its environmental impacts; EMA as a subject field, tools or methodologies such as material flow cost accounting; the regulatory environment; the environmental strategy, uses as well as benefits of EMA, decision making for instance; and EMA as a tool to support management decisions and improved costing. Propositions were identified in this chapter. The preliminary framework presented at the end of Chapter 2 was modified based on the input received from the personal interviews and a focus group that was carried out to validate the framework.

2.1.2. Layout of Chapter 2

The layout of the Chapter is as follows: In Section 2.1 the chapter is introduced. Section 2.2 identifies the theoretical lens of the study. Section 2.3 portrays the information technology, information systems and its purpose. The impact of coal

mining on the natural environment is illustrated in Section 2.4 whilst a conceptual framework for coal mining operations and its environmental impacts is discussed in Section 2.5. Section 2.5.1 does a comparison of the Centralia and Blesboklaagte coalmines whereas Section 2.6 presents the health impacts of coal mining on employees and local communities. Section 2.7 portrays environmental management accounting. This is followed by Section 2.8 with pitfalls of EMA, and Section 2.9 discusses the social license to operate. In Section 2.10, factors influencing the success of EMA are discussed whilst the link between EMA adoption and EMA implementation is portrayed in Section 2.11. The relevance of environmental costs is shown in Section 2.12. Section 2.13 discusses the implementation of EMA in a day whereas Section 2.14 provides the barriers/pitfalls of EMA adoption and implementation. In Section 2.15 the benefits of EMA for the coal mining industry are discussed followed by Section 2.16 on the material usage in the production process. Section 2.17 portrays the tools and methodologies: material flow cost accounting followed by Section 2.18 regarding the regulatory environment. The environmental strategy is discussed in Section 2.19 followed by Section 2.20 on uses and benefits of EMA. Section 2.21 provides a discussion on decision-making: EMA as a tool to support management decisions, and Section 2.22 explores improved costing. The chapter concludes with a summary in Section 2.23.

Previous Work: It is noted that a large part of the literature findings in this chapter has been published as a journal paper (Mbedzi, van der Poll & van der Poll, 2018) which appears as Appendix F.

2.1 THE USE OF PROPOSITIONS

In the spirit of an inductive research approach for a qualitative research choice, propositions are defined in this chapter on the strength of the literature review performed. The propositions are divided into three (3) groups:

- **General** Propositions represent general or overarching propositions and are labelled *pG1*, *pG2*, …, *pGi*.
- **Content** Propositions indicate content of concepts identified throughout. Content propositions are labelled *pC1*, *pC2*, …, *pCj*.
- **Association** Propositions represent the links identified between concepts. Associations are indicated by *pA1*, *pA2*, …, *pAk.*

The above propositions are used to construct the preliminary framework shown in Figure 2.19.

The theoretical underpinnings of the research are discussed next.

2.2. THEORETICAL LENS

Two theories are identified as the theoretical lens for the study, namely: Sustainability and Stakeholder theories.

2.2.1. Sustainability theory

The World Commission on Environment and Development (WCED) generated a report in 1987, 'Our Common Future' under Gro Harlem Brundtland, defining sustainable development as growth which addresses the requirements of the current without compromising the capability of forthcoming generations to meet their personal necessities (WCED, 1987). Sustainability has been argued as the capacity to exist in harmony with nature. It implies that humans should exist within the limitations of current natural environmental resources. In general, sustainability is considered as the aptitude to endure support from an environmental perspective as the quality of not being destructive to the environment and its limited resources thereby maintaining a lasting environmental sense of balance. However, sustainability is at risk due to the global need for more resources. In the present day, the strategic significance for sustainability for companies has increased over the past years (IFAC, 2005:1).

Gray (2010:8) correctly argues that most business reporting on core business activities regarding sustainability have slight, if anything to do with sustainability. Ansari and Kant (2017:2525) as well as Gadenne, Mia, Sands, Winata and Hooi (2012:210) suggested that the strategic significance of sustainability for companies has increased over the past decades. However, Morioka and de Carvalho (2016:135) noted that sustainability requires considering both development and the environment, implying that development of all ought to be continued within the confines of nature. However, sustainability cannot be considered only at the company level, but should include deliberations of its impact on the environment beyond legal restrictions (Bebbington, 2001:128).

Murombo (2013:37) narrows the argument from a global perspective to operational level by arguing that sustainability in the mining industry means that mining companies

should work in good faith within the local communities to ensure that the mining sector contributes to social, economic as well as environmental matters. For instance, mining companies could assist local communities by building churches, schools, roads and community halls, create more jobs, and contribute into community trusts.

2.2.1.1. The three pillars of sustainability

Purvis, Mao and Robinson (2019:691) opined that the origins of the three (3) pillars of sustainability (environment, social and economic) are not clear. However, one predominant narrative of sustainability includes three interlinked pillars. These pillars of sustainability are multidisciplinary and the solutions-driven methodology for sustainable development, namely social, environment, and economic. Lamberton (2005:8) clarifies that the three (3) pillars of sustainability are in most instances referred to as the triple bottom line (TBL) for sustainable development (SD). This form of sustainability seeks to enable companies to disclose their environmental impacts.

The three (3) pillars are simultaneously a methodology to entrench sustainability goals including contemplations into the fabric of more of our social ideas and institutional practices. It is a way of making provision for the correct mix of considerations to implement sustainability solutions effectively at a faster pace and scale (Clune & Zehnder, 2018:211). The implications of this approach are immediate and highly impactful for applied and project-level applications. Similarly, it supports the process of taking informed decisions and having balanced priorities at different public policy, law-making and governance levels. The major shortfall for sustainability conceptualisation is its lack of theoretical development. There seems to be no original information from which it is derived, seemingly just appearing in the literature and generally considered at face value (Giddings, Hopwood, & O'Brien, 2002:187).

Figure 2.1 portrays the economic, environmental and social extents of sustainable mining (S.M).

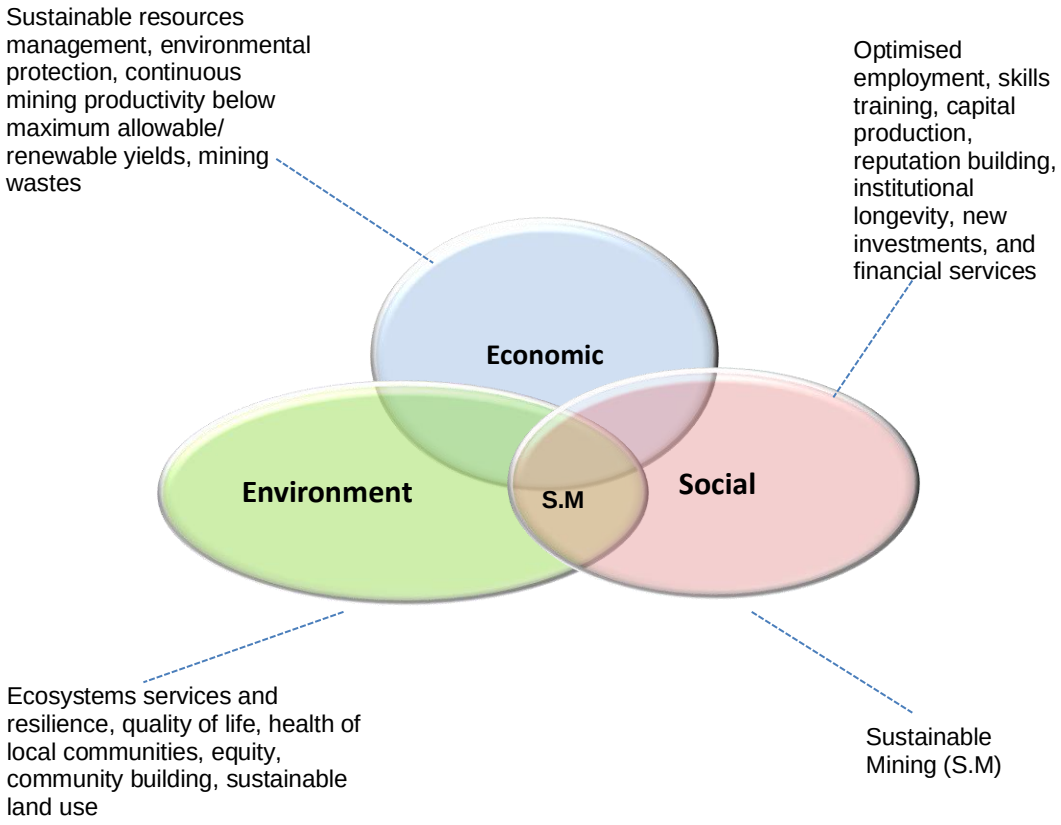

Figure 2.1: The economic, environmental and social extents of sustainable mining (SM)

Source: *Munasinghe (1993:2, 2000:1)*

Based on Figure 2.1, it can be contended that S.M. can be efficient when mining companies implement minimal steps to protect the environment in which they operate. This means that they should involve the society as a key stakeholder. For instance, they ought to employ people from local communities and be involved in outreach programmes (Munasinghe, 1993:2, 2000:1).

The mining industry is a sector that has major environmental impacts that requires urgent consideration in the employment of strategies which will lead to a decrease of environmental impacts. Therefore, mining companies should strive for sustainable resources management, environmental protection, and continuous mining productivity below maximum renewable yields and mining wastes (economic). Companies should optimise employment, skills training in the local communities, capital production, reputation building, institutional longevity, new investments and financial services (social). Moreover, be able to manage the ecosystem and resilience, quality of life, health of local communities, equity and community building, and utilise the land in a

sustainable way (Pan, Oates, Ihlenfeld, Plant & Voulvoulis, 2010:570; Fülöp & Hernádi, 2014:2).

2.2.1.2. Natural capital in the context of sustainable mining

Zvarivadza (2018:75) opines that environmental stewardship is the foundation to sustainability in the mining industry. While environmental compliance is considered expensive due to costs implementation, it does, however, provide mining companies with a competitive edge. For instance, a sustainable mining project takes into consideration its impacts on the environment and implements suitable mitigation processes to control these impacts.

However, it has been argued that the two (2) contending concepts of sustainability differ regarding the affiliation amongst natural capital or artificial capital. Weak sustainability signifies the notion that natural capitals and industrial resources are replaceable. Therefore, sustainability could be achieved when an overall value of investment remains constant. Based on this principle, companies could be considered sustainable if their activities minimise the number of environmental impacts whilst at the same time generating profit (Kirsch, 2010:90).

2.2.2. Development of theories

Chen and Roberts (2010:651) demonstrate ways in which theories were developed and how they interrelate. These are theories such as legitimacy theory, institutional theory, and strategy legitimacy that is subdivided into resource development theory and stakeholder theory. Stakeholders can be classified into two (2) categories, namely primary and secondary stakeholders. Primary stakeholders imply participants who are directly interested with a contractual relationship, as the name specifies, with the company (also called contractual shareholders.) Secondary stakeholders comprise actors with vested interests who may be affected by the company's activities without having any contractual association (Caroll & Buchholtz, 2008:82). Stakeholder engagement in sustainability matters is vital for the legitimacy as well as quality of decisions. Ethical considerations have driven growth of stakeholder theory (Gibassier & Alcouffe, 2018:10; Squires & Elnanhla, 2020:126).

Stakeholders include shareholders; employees; unions (internal stakeholders); customers; local communities; environmental groups; government and local

authorities (external stakeholders); suppliers as well as non-governmental organisations (NGOs) (Chen & Roberts, 2010:653). As decisions within companies become politicised, the need for awareness to grow into responsiveness has become apparent (Rasi, Abdekhodaee & Nagarajah, 2014:144).

Figure 2.2 presents these theories in detail.

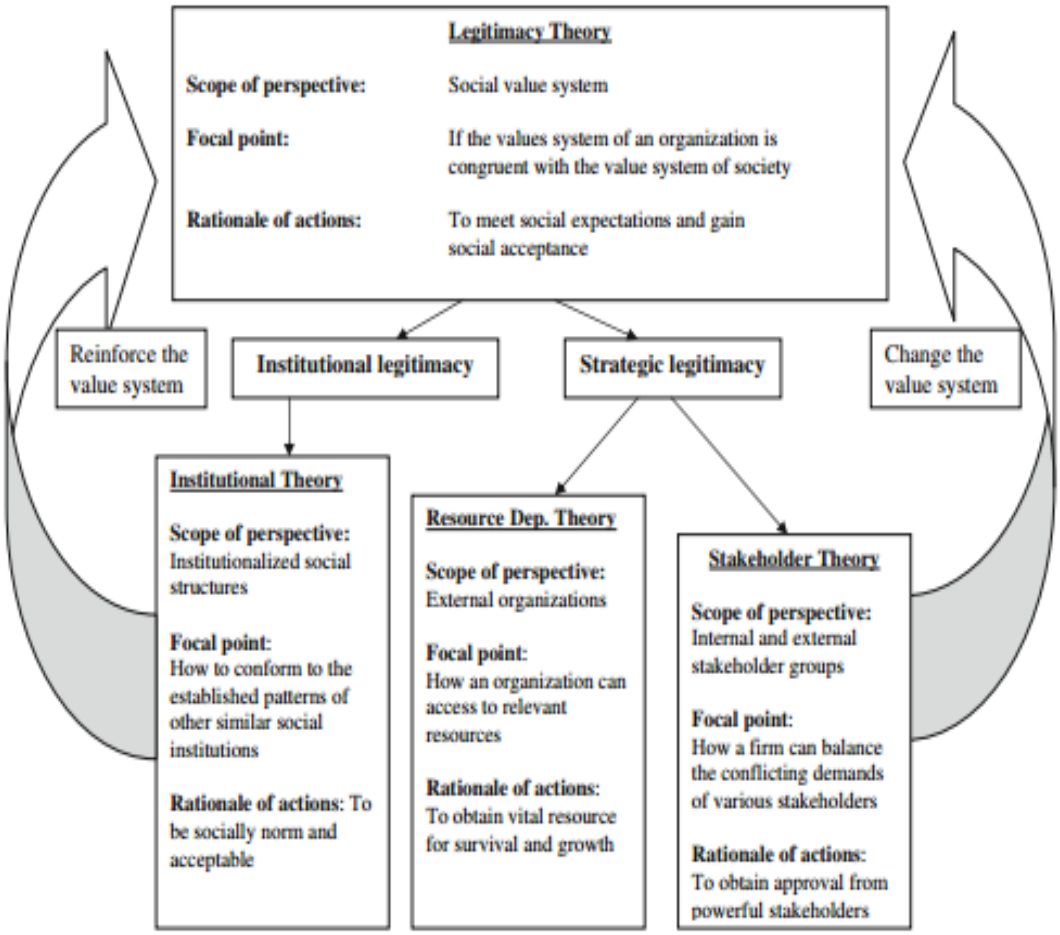

Figure 2.2: Relationship among the theories

Source: *Chen and Roberts (2010:653)*

Figure 2.2 indicates the relationship between legitimacy, institutional legitimacy and strategic legitimacy theories. Legitimacy theory is founded on the premise that the values of the companies should be aligned or congruent with the values of the local communities in which they (companies) function. The rationale of the legitimacy theory is to meet social anticipations to achieve social recognition. The scope of the social value system is divided into institutional and strategic legitimacy. Institutional legitimacy links up with legitimacy theory that has its scope as institutionalised social

structures. For instance, how companies should conduct themselves as per the acceptable norms. The institutional theory in the end reinforces the value system and links back to the legitimacy theory again (Silva, Nuzum & Schaltegger, 2019:204).

The concept of societal legitimacy is essential for all theories under consideration in this instance (stakeholder, institutional, legitimacy and resource dependence theory lenses). Consequently, these theories emphasise the role of external actors in conveying accepted notions about management practices to the organisation by giving emphasis to either the relationship with external actors or wider institutional norms. Theories of internal actors put emphasis on internal procedures of companies, where CSR is either conceptualised as a result of management decisions as well as economic projections or ethical judgments (Frynas & Yimahaki, 2016:261; Hillman, Withers & Collins, 2009:1416; Amis, Barney, Mahoney & Wang, 2020:499).

Companies may need to be aware of the relationship between all these theories to be able to create rapport with local communities. The strategic legitimacy is divided into two (2) theories, namely the resource development theory where the focal point is on how companies access relevant resources, for example, in this study coal deposits.

2.2.2.1. Corporate social responsibility

Corporate Social Responsibility (CSRx) (x = 1 or 2 – see Figure 2.3) is a generic for two (2) forms, namely Corporate Social Responsiveness (CSR1) and Corporate Social Responsibility (CSR2). Modern companies are managed for example by CEOs and managers, and justifiably, it is in the interest of management as well as shareholders to increase their profit margin and to strive for sustainable competitive advantage. Contrary to this process, managers often overlook environmental matters and the impact their company activities have on the environment (Ditlev-Simonsen & Brøgger, 2013:117).

Greenwood and van Burden (2010:426) stress the significance of having trust as a moral exchange between companies and its stakeholders. Trust in the company-stakeholder relationship and the trustworthiness of the company is central to the moral conduct of investors. Therefore, the board of directors for these companies should have a clear strategy on how to deal with employee representative groups. These include trade unions as these may compromise or slow down operational activities due to strikes. Hence only stakeholders committed to CSR may have a real impact on

unions' CSR approaches. For example, employees with a proactive CSR strategy may observe a higher prospective to cooperate among stakeholders that are committed to CSR than employees with a reactive or defensive strategy (Freeman & Reed, 1983:95; Sobczak & Havard, 2015:314).

Figure 2.3 portrays the impact of employees' perception of and relations with stakeholders on their CSR.

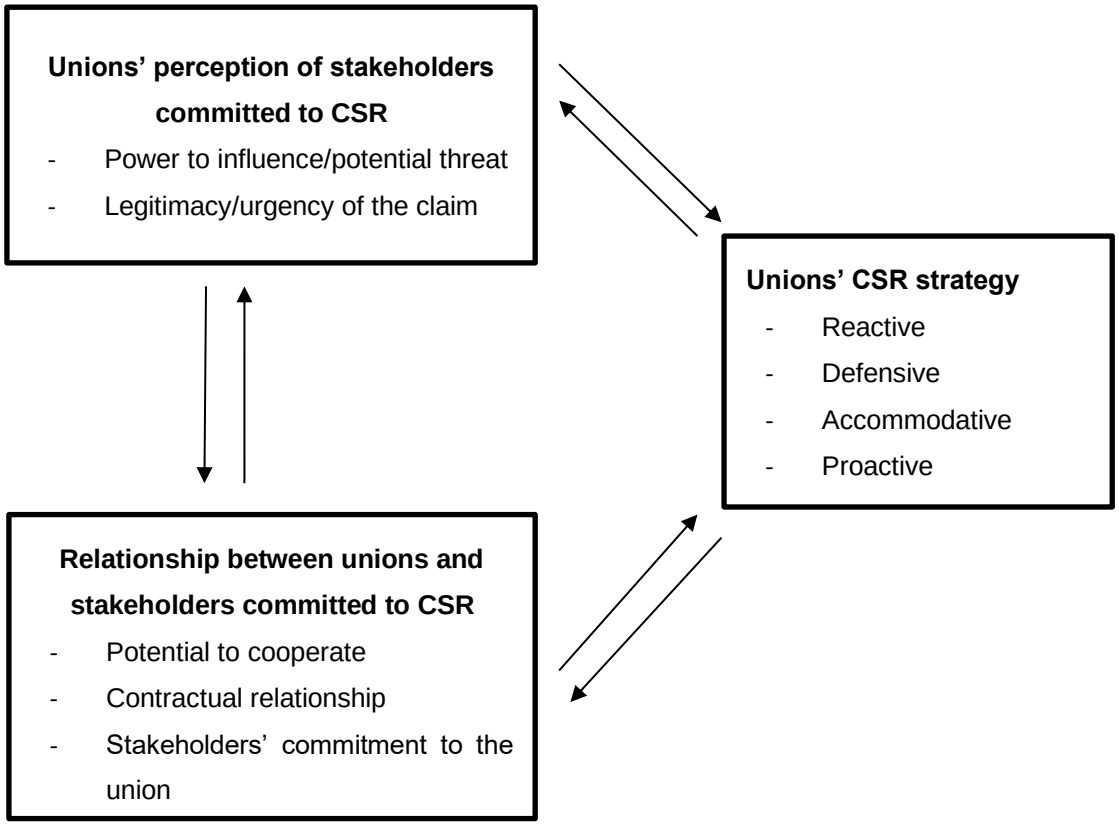

Figure 2.3: Impact of unions' perception of and relations with stakeholders on their CSR

Source: *Sobczak and Havard (2015:315)*

Figure 2.3 demonstrates the interrelationship between the unions' perception of stakeholders committed to CSR, the unions' CSR strategy, and the relationships between the unions and stakeholders committed to CSR. The solid arrows indicate the flow of information or transfer of data between the variables. Therefore, there should be good rapport between unions and companies. Whatever relationship or issue at hand will determine the reaction of the unions; for instance, on whether they want more people to be employed within companies. The other argument will be when

unions are defensive; for example, if they feel that companies want to retrench their members. The arrows demonstrate interdependency between the employees' perception of stakeholders committed to CSR, the Unions' CSR strategy, and the relationship between employees and stakeholders committed to CSR.

The discussion on stakeholder groups gives rise to our 1st general proposition:

- PROPOSITION *PG1*: Stakeholders denoting investors in the coal mining industry are external to the environment, while employees (including member unions) are internal to the environment.

2.3. INFORMATION TECHNOLOGY, INFORMATION SYSTEMS AND ITS PURPOSE

Information systems (ISs) are founded on a generalised idea of an operational structure. Companies function through functional systems (Alter, 2008:6). Typical businesses encompass work systems which source products from service providers. These companies assemble and supply products to consumers; generate financial reports; appoint employees; and perform many other functions (Stockdale & Standing, 2006:1100). However, this does not stop the general system from being a social system and arguably, it is not probable to invent a dynamic, effective IS, integrating substantial expanses of technology without considering it as a societal structure (Gupta, 2018:780).

2.3.1. Management Information Systems (MIS)

If ISs are regarded as societal and technical companies and shareholders are fundamental to each phase of IS, then outdated approaches of IS appraisal grounded on the usage of technical methods are no longer adequate. An MIS is one of the major essential instruments in any business, which seek to make available consistent, comprehensive, accessible and comprehensible information in a timely way to the customers of the system (Al-Mamary, Shamsuddin, & Aziati, 2014:22; Babaei & Beikzad, 2013:378). Additionally, an MIS assists in enhanced organisational efficiency, improved consumer fulfilment and adeptness of the work. An MIS is mainly concerned with the procedure of gathering, processing, storage as well as communicating applicable information to promote the managerial operations within a business (Gupta, 2018:780).

The above ICT-related discussion leads to our 1st content-driven proposition:

- PROPOSITION *PC1*: A good quality and reliable MIS (Management Information System) is vital to facilitate the operations of a coal mining company.

In the previous section, it was demonstrated that stakeholder theories are critical for companies to have good rapport with their stakeholders. Further deliberation on stakeholder theories established that companies must strive to meet social expectations to gain social acceptance. By doing this, companies will be able to achieve corporate sustainability.

2.4. IMPACT OF COAL MINING ON THE NATURAL ENVIRONMENT

This section discusses the impacts of coal mining operations by looking at the uniqueness of coal mining. Furthermore, this chapter will deliberate on the impact of coal mining on the environment, humans, fauna and flora as well as on the conceptual framework for mining operations and its environmental impacts.

2.4.1. Uniqueness of coal mining

Mathu and Chinomona (2013:347) acknowledge that the use of coal deposits as a non-renewable resource has contributed to the socio-economic wellbeing of South Africa. For instance, the use of coal in the generation of electricity is significant in the country. However, the mining of coal deposits is associated with environmental impacts. These include disturbance of the landscape for agricultural purposes, which also affect forestry, causes water pollution and human diseases. Lloyd (2002:1) suggests that the considerable impact of coal mining in South Africa is attributed to the large quantities of coal (nearly 300 million tons each year) that is mined and conveyed. In South Africa, Masante, McCormick, Vogt, Carmona-Moreno, Cordano and Ameztoy (2018:4) highlight the eminent severe drought due to water scarcity in the Western Cape Province. This was exacerbated by the low amount of rainfall that has been experienced since 2015 which led to water cuts and rationing by the Cape Town water authorities in 2017 as well as 2018. Considering these water challenges, the researcher opines that the South African government should consider adopting additional renewable sources of energy other than coal such as wind, solar power and the use of water to generate electricity.

2.4.2. Impacts of coal mining on the environment

It has been established that coal occurs in different forms and qualities, mostly hard coal, brown coal which includes coking coal used to produce steel, and other bituminous (sub-bituminous and lignite) that is essentially utilised as onsite fuel. Coal has a broad range of content characteristics such as moisture and sulphur including ash content. This might affect the quality of coal as well as its environmental impacts (Fatah, 2008:86).

Northey, Mudd, Saarivuori, Wessman-Jääskeläinen and Haque (2016:1098) argue that the interfaces of the mining industry with water resources are highly complex and site-specific, with potential impacts to both hydrology and water quality occurring at all stages of a mine's life. A range of water management methodologies have been adopted by the mining industry to alleviate risks of adverse water impacts occurring. Accordingly, the substantial inconsistency within the industry poses a range of challenges when making an effort to quantify the water footprint of mining operations and mineral commodities.

Hutton, Kahan, Naidu and Gunther (2009:425) report that the other risk is on the formation of AMD whereby iron oxide forms an unsightly coating on the bottom streams, and further limits the ability of aquatic life to survive in streams affected by AMD. When sulphide minerals found in mine rock reacts with air and water to form sulphuric acid, it forms AMD. It creates an environmental challenge thereby contributing to both ground and surface water pollution with higher levels of sulphate. Figure 2.4 shows an example of AMD and its related impacts.

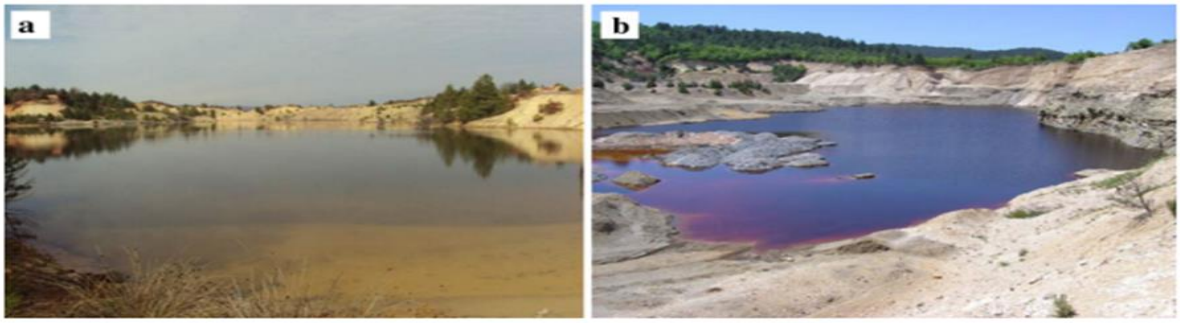

Figure 2.4: An example of acid mine drainage in the lakes

Source: *Yucel and Baba (2013:359)*

Figure 2.4 depicts two (2) images. Image (a) shows clean water whilst image (b) shows water contaminated with AMD due to mining activities. The researcher opines that mining companies should consider the environmental implications so that their mining activities do not cause environmental degradation or the contamination of water.

Caliman, Robu, Smaranda, Pavel and Gavrilescu (2011:242) suggest that human and environmental receptors are exceedingly restrained due to the release of AMD. However, repetitive remedial action and controlling of AMD are imperative for guiding the emphasis and resources on the potentially maximum damaging risks. Consequently, mining is a complex process hence relevant mitigation of risk should be considered. Several mining activities cause toxic waste and contaminate groundwater. For instance, leakage from municipal areas and landfills, deserted dumping areas, hazardous spillage or toxic effluent, assignment of drain sewer facilities in hydrological and geographical localities that affects agricultural processes. Sarma, Kushwaha and Singh (2010:84) observed that extensive mining has led to the sterilisation of land and affected the likelihoods of the restoration of fauna and flora. For instance, the totals of herbaceous plant types inhabiting the mined parts were found to be greater compared to the unmined zones.

The review of the literature in the foregoing section established that, although coal mining is unique in nature, mining activities create environmental challenges such as human diseases and environmental pollution.

The following section discusses a conceptual framework for mining operations and its environmental impact.

2.5. A CONCEPTUAL FRAMEWORK FOR COAL MINING OPERATIONS AND ITS ENVIRONMENTAL IMPACTS

Ile, Eresia-Eke and Allen-Ile (2012:98) consider a conceptual framework as a planning map demonstrating the key theories of a programme. The framework enables interested groups to get a better sense of the planner's thinking, equipping them to contribute meaningfully to improve the intervention's chances of delivering intended benefits to targeted groups in society.

Stemming from the preceding argument, Miles, Huberman and Saldaña, (2014:20) elaborate on the argument by Ile *et al.* (2012:98) by indicating that conceptual frameworks explain, either graphically or in a narrative form, the key concepts being investigated - major factors, variables, or constructs, and furthermore, the presumed interrelationships amongst them. Frameworks can be simple or theory driven, descriptive and casual in nature. Conceptual frameworks serve as a researcher's map that provides a terrain under investigation. As the researcher's knowledge of the terrain progresses, the map becomes congruently more differentiated and assimilated. Therefore, a conceptual framework is developed at the beginning of a study and evolves as the study progresses.

Ribeiro and Aibar-Guzman (2010:404) deliberate on the relevance of frameworks in that the challenge remains to be the application and integration of these frameworks into operational processes within companies. Fears regarding the sustainability and protection of the natural environment have generally become imperative matters among regulators, environmentalists, and the public in several countries. In this circumstance, comparable to what has transpired in privately owned businesses; there has been a growing focus amongst public entities on the necessity to address environmental management. As a result, companies have increasingly insisted on developing and implementing management practices and tools intended to promote their environmental performance (Ribeiro & Aibar-Guzman, 2010:404).

The researcher agrees with the preceding argument since the preliminary framework presented at the end of Chapter 2 was enhanced as presented at the end of Chapter 5.

Figure 2.5 demonstrates the conceptual model of mining operations.

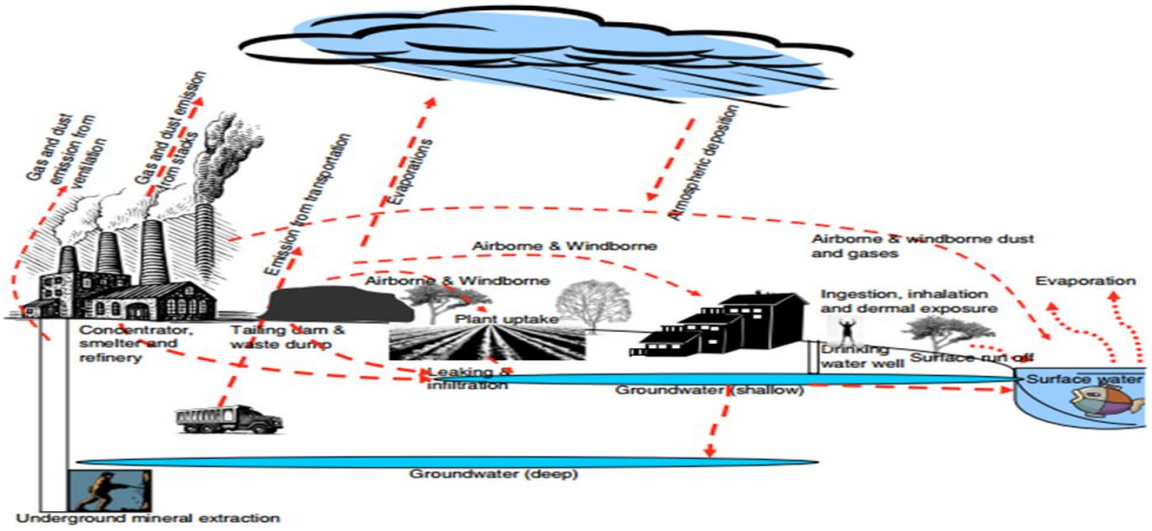

Figure 2.5: Conceptual model of mining operations

Source: *Pan et al. (2010:561)*

Based on Figure 2.5, Pan *et al*. (2010:561) argued that a source of pollution describes the origin of a hazard such as contaminated waste water from the coalmine, the pathway as how the danger reaches a receptor. For instance, leakages and spills of polluted wastewater into ground and surface water thereby increasing potentially harmful chemical concentrations. This has the potential to affect aquatic flora and fauna and species at trophic levels higher up the food chain, specifically those that are not able to withstand a higher content of heavy metals. Kirsch (2010:88) elaborates by arguing that pollution from a single mining project can affect hundreds of square kilometres and AMD can render environments inhospitable to organic life for centuries.

However, Gavriletea (2017:19) focusses on the mitigation of environmental impacts by suggesting that companies should be cognisant of their environmental impacts. Furthermore, companies should start thinking about environmental costs and include it as part of the production process. A company that operates in this sector should be focused both in determining, monitoring and reducing negative environmental impacts on this activity and in finding and applying solutions for various types of pollution.

On the other hand, Liphadzi and Vermaak (2017:609) suggest that environmental sustainability may be attained within the mining industry when companies implement water saving strategies to improve their performance on elements and indicators promoting sustainable water management as depicted in Figure 2.6.

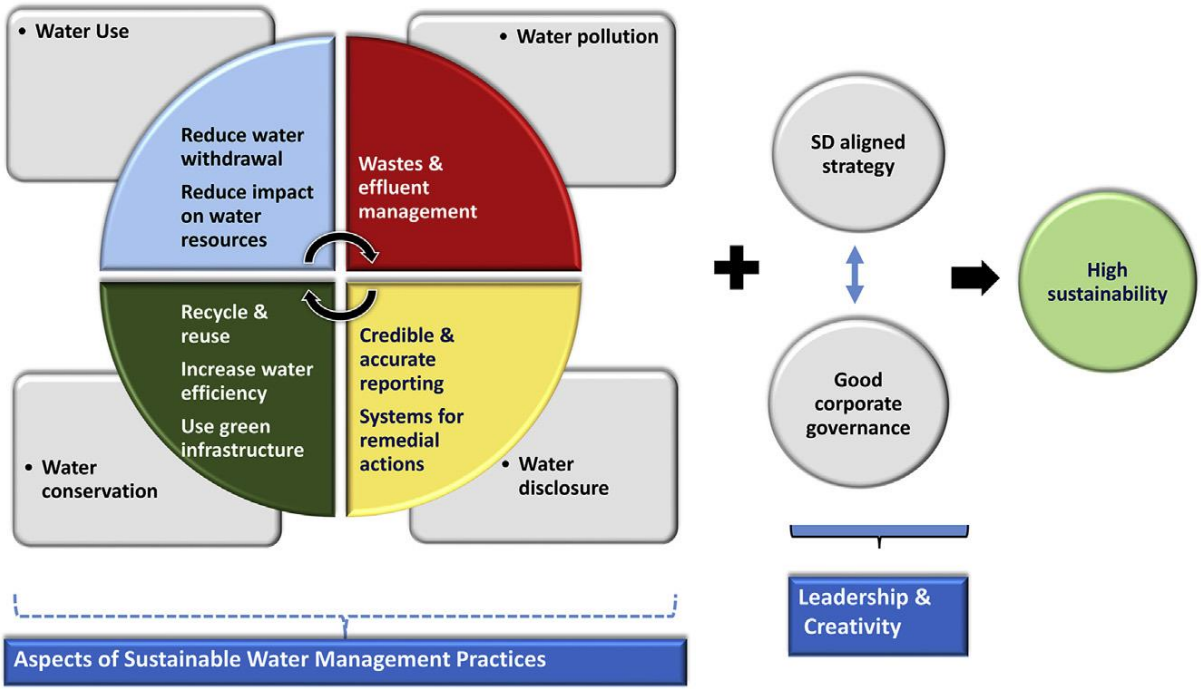

Figure 2.6: conceptual model for sustainable water management in the mining industry

Source: *Liphadzi and Vermaak (2017:609)*

It can be demonstrated in Figure 2.6 that there are four water saving strategies, namely water use in terms of reducing the withdrawal of water and impact on water resources thereof; water conservation such as the recycling and reuse, increasing water efficiency through green infrastructure, for instance water reservoirs. The other strategies include water pollution, namely the control of wastes and effluent management; water disclosure such as credible and providing reports on the accuracy of water usage as well as mitigation strategies thereof. These four strategies should enhance a sustainable development aligned water strategy to achieve good corporate governance through leadership creativity to achieve high sustainability. The researcher postulates that coal mining companies should corroborate with government (local and national) in finding sustainable solutions regarding the use of water. Moreover, they should disclose the environmental impacts of their mining operations thereby showing their social and environmental accountability.

Dheda, Harding and Sheridan (2015:1) consider water as a precious part of our existence that is needed for food production, drinking and basic hygiene. It also forms the basis of our ecosystems and economies. In contrast, there is a global water crisis due to climate change, the increase in populations internationally, and increased

industrial and agricultural activities. Therefore, South Africa is also faced with water stressors as the country has widespread mineral resources with limited water supply thereby making mining attractive for the economic sector but strenuous for the water sector.

2.6. COMPARISON OF THE CENTRALIA AND BLESBOKLAAGTE COALMINES

Centralia is a minor town in Pennsylvania, USA which has been deserted by its community because of a coalmine that has been burning since 1962, 57 years at the time of writing. It is projected that the underground fires will continue to burn for the next 250 years and underground coal fires have destroyed the town. The town used to have a population of an estimated one hundred inhabitants; however, most people have left with less than ten remaining (De Brito, 2017:1). Additionally, the number of graves at the cemetery is more than the number of residents living in the area. The area is now characterised by dilapidated infrastructure such as cracked roads, smoke emanating from the ground, drawings on uninhibited buildings, derelict structures and signage warning residents that the surface might collapse or curve in at any time. Furthermore, children died after falling into the sinkholes, therefore, causing a danger to society. The closest town of Barnesville was abandoned due to underground fires (De Brito, 2017:1).

Figure 2.7 shows a burning road at the Centralia coalmine, Pennsylvania in the USA whilst Figure 2.8 shows the burning houses in the same area.

Figure 2.7: Burning road at the Centralia coalmine, Pennsylvania

Source: *De Brito (2017:1)*

Figure 2.8: Burning houses at the Centralia coal mine, Pennsylvania

Source: *De Brito (2017:1)*

Figure 2.8 depicts a burning sinkhole on a tar road and a deserted residential area that has been affected by underground coal fires. Similar to the case of Centralia coalmine, in South Africa for instance, EO-Miners (2016:1) reports that Blesboklaagte situated in the eastern part of Ferrobank industrial region in Emalahleni has been undermined. After the original board and pillar mine operations ceased, the roof of the shallow mine curved in hence subsidence formed over a wide area. This is validated by board and pillar (the shallow roof of the mine) structures that have collapsed as well as the presence of coal disposal dumps. The underground fires have been burning since 1953, which is about 66 years at the time of writing. When the mining activities ceased, the original board and pillar curved in and warped, and sagging formed over an extensive area.

EO-Miners (2016:1) elaborate that these subsiding landscapes can be observed in residential zones as well as the abandoned areas south of the airfield and north of an informal settlement. Warning signs are indicative that the area is unsafe as demonstrated by the markings on the tar road. The main challenge and danger are that residents from the informal settlement walk across this area daily, unmindful of the hazards facing them.

Figure 2.9 shows a burning collapsed coal mining area (sinkhole).

Figure 2.9: Blesboklaagte burning collapsed sink hole

Source: *EO-Miners (2016)*

The researcher argues that the two (2) case studies demonstrate similarities in terms of the dangers caused by the underground fires such as sink holes, damage to the environment, toxic emissions, and deformed landscapes. Other similarities include the duration of the underground fires and sinkholes. Although the extent of the damage at the Centralia mine is large, it is significant to the Blesboklaagte mine in that most of the coal mining activities occur in Emalahleni. Hence, the risk of other coalmines catching fire in the Emalahleni area in the future is high and may be detrimental to the environment. The challenge for the South African case study (Blesboklaagte mine) is that the extent of the underground fires and associated damage in not known.

The discussions in the preceding sections led to our 2nd content proposition:

- PROPOSITION *PC2:* In the absence of any remedial interventions, coal mining practices have detrimental effects on the environment, specifically the pollution of surface- and underground water.

The following section provides a discussion on the health impacts of coal mining on employees as well as local communities.

2.7. HEALTH IMPACTS OF COAL MINING ON EMPLOYEES AND LOCAL COMMUNITIES

Mahdevari and Shahriar (2016:3) observed that mining-related diseases are diseases caused by physical, chemical and biological dangers which result from working within coalmines. Chemical hazards in underground mines that are mainly airborne result from the inhalation of coal dust, particulates, naturally occurring gases, engine exhaust

and chemical vapours. Amongst these, coal dust is the major airborne danger and a main cause of most incidences such as respiratory diseases. Derickson (2013:239) identifies the mining activities that have led to human impacts such as pneumoconiosis, anthracic-silicosis, and black lung disease. For instance, a rampant of dust-induced protracted respirational illness affected a considerable number of workers in American bituminous region and anthracite collieries in the mid-20th century. Yanhui (2014:127) proposes that mining companies may need to conduct regular health checks to detect looming illnesses that might affect the mineworkers. In South Africa, the Kings (2019:1) reported that polluted air in areas such as Johannesburg, Pretoria, Durban, Bloemfontein and Cape Town caused deaths to young and old people as well as unborn babies. The estimated death toll is 54 people a day.

Finkelman, Belkin and Zheng (1999:3427); and Huang, Ghio and Maier (2012:32) identify countries in which the Balkan endemic nephropathy (BEN) occurred due to mining. These are Serbia, Bulgaria, Romania, Croatia, and Bosnia and Herzegovina. This disease is associated with lignite and was noted as an influential cause in a severe, devastating kidney illness by means of related urinary track cancers. However, Stiborova, Arlt and Scheiser (2016:2597) further identified the symptoms relating to the BEN disease caused by effluents or gasses emanating from mining. Symptoms include archetypal indications of arsenic eradication, together with hyperpigmentation (flushed appearance and freckles), hyperkeratosis (flaking grazes on the skin, commonly concerted on the hands and feet), Bowen's illness, which is the dark, horny and precancerous cuts of the skin.

Page (2003:30) describes the type of mining activities that cause silica (a powder generated from several causes) which consist of, but are not restricted to, cutting, boring or grinding of pillar waste matter. With respect to mining, this pillar material is established as an intrinsic fundamental of energy, even though this is customarily not as imperative basis of silica. The major processes which create dust include drilling, blasting, stacking, and unpacking, including transportation.

The discussions in the preceding sections led to our next content proposition:

- PROPOSITION *PC3:* In the absence of any remedial interventions, coal mining practices may severely affect animal and human health.

From the above proposition we may infer:

- PROPOSITION *PC4*: Health regulations ought to be put in place for the coal mining industry.

The following section explores EMA and its concepts.

2.8. ENVIRONMENTAL MANAGEMENT ACCOUNTING – THE SUBJECT FIELD

In the following sub-sections, EMA and its concepts, as well as the conceptual framework of EMA are discussed.

2.8.1. EMA and its concepts

Although EMA is regarded as a business tool that provides information desirable for corporate environmental management, little evidence has been provided indicating the successful implementation of EMA by companies. It is further defined as the managing of environmental and financial performance through the improvement and application of relevant environmentally linked accounting systems and processes. Therefore, tools, systems and practices should be developed to manage the environment. However, there may be no agreement on the scope, measures, or descriptions of EMA (Setthasakko, 2010:315; Burritt, Herzig, Schaltegger & Viere, 2019:479).EMA is categorised into two (2) major elements, namely monetary EMA (MEMA) and physical EMA (PEMA). MEMA focuses on environmental aspects of company activities expressed in financial units. For instance, measures expressed in costs on cleaner production (CP), costs of fines for breaking environmental laws, investment in capital projects that improve the environment, and monetary values of environmental assets. For example, in MEMA, product costing implies a wider range that includes tracing of direct as well as indirect environmental costs for instance, costs of permits, fees and reusing of products. Another example of MEMA is the contemplation of environmentally induced incomes such as revenue contributions from producing greener products (Tsui, 2014:3). Meanwhile, physical EMA (PEMA) refers to a company's impact on the natural environment, expressed in terms of physical units such as kilograms, cubic metres or joules, for instance, kilograms of material per customer served, joules of energy used per unit product (Schaltegger *et al*., 2000:18).

The researcher opines that a key difference between MEMA and PEMA is the type of measurement used and information resulted, specifically financial and non-financial measures as well as information, respectively. In short, MEMA seems to be concerned with the impact on the environment on the company's financial performance and PEMA is about direct effects on the environment.

These two (2) streams of EMA are discussed in the next section in order to provide a better understanding of EMA.

2.8.2. The conceptual framework of EMA

In this section, the conceptual framework by Schaltegger *et al.* (2000:14) is discussed as portrayed in Table 2.3. The comparison between the two (2) branches of EMA (the financial as well as physical aspects) will be extensively deliberated.

Table 2.1: Comprehensive structure of EMA

Environmental Management Accounting (EMA)						
		Monetary Environmental Management Accounting (MEMA)			**Physical Environmental Management Accounting (PEMA)**	
		Short Term Focus	**Long Term Focus**		**Short Term Focus**	**Long Term Focus**
Past Focussed	Regularly produced statistics	Environmental cost accounting (ECA) for instance, variable valuation, absorption valuation including activity-based valuation	Environmentally persuaded capital, disbursement and profits		Material and energy flow computing (short term effects on the atmosphere – products, location, department and business ranks)	Environmental (or natural) capital impact computing
	Ad hoc facts	Ex Post valuation of related environmental appraisal resolutions	Environmental lifetime (and objective) valuation		Ex post valuation of short-term environmental bearings (for instance, of a place or products)	Lifespan records Post asset valuation of physical environmental asset assessment

Environmental Management Accounting (EMA)						
		Monetary Environmental Management Accounting (MEMA)			Physical Environmental Management Accounting (PEMA)	
		Short Term Focus	**Long Term Focus**		**Short Term Focus**	**Long Term Focus**
Future Focused	Regularly created evidence	Financial environmental operating forecasting (movements) Financial environmental capital planning (bonds)	Environmental long-term financial forecasting		Physical environmental planning (flows and bonds) for instance, material and energy flow movement-based planning)	Long term physical environmental forecasting
	Ad hoc statistics	Applicable environmental assessment (for instance, exceptional orders, products combination with volume restraint)	Financial environmental project venture evaluation environmental lifespan planning and objective valuation		Applicable environmental effects (e.g. considering short run constrictions on activities)	Physical environmental venture assessment Lifespan scrutiny of explicit projects

Source: *Schaltegger et al. (2000:14)*

The conceptual framework presented in Table 2.1 by Schaltegger *et al.* (2000:14) discusses the EMA conceptual framework by comparing the two (2) methodologies to define EMA. Their advantages and disadvantages show that sound opinions exist for both perspectives. Given the supposition that the philosophy and the tools linked with EMA may support the drive to achieve a sustainable society, it is imperative to create a common understanding of EMA, to facilitate its communication and promotion amongst managers and shareholders (Christ & Burritt, 2013:163).

Although the researcher notes that this conceptual framework might serve as a guideline to the South African government, there is little or no evidence as to how South African companies should implement and integrate this framework in order to mitigate environmental impacts. This could be attributed to costs associated with the implementation of EMA and lack of knowledge of the subject matter. The high costs of implementing EMA were also criticised by the United Nations (UN) who compared it to short-term benefits instead of long-term benefits (UN, 2001).

This could be the reason why companies in South Africa are reluctant to implement EMA as it is focuses on the bottom line. Even though Schaltegger *et al*. (2000:6) suggested EMA as a strategic information management tool for internal management decisions, the researcher argues that EMA is a multi-disciplinary tool that requires skill and knowledge from different disciplines such as operations, accounting, mining, processing, and logistics. The question is whether companies in South Africa are implementing EMA, and if so, to what extent has EMA been implemented in South Africa and is it aligned to suggestions by Schaltegger *et al*.'s (2000:6) conceptual frameworks?

Although the preceding section demonstrated that there are two (2) branches of EMA, namely MEMA and PEMA, the adoption and implementation of EMA is entirely dependent on the companies as its implementation in South Africa is on a voluntary basis.

The discussions in the preceding sections led to:

- PROPOSITION *PC5:* Environmental Management Accounting (EMA) may usefully be employed to facilitate sustainability in the coal mining industry.

The following section explores the EMA challenges and current accounting practices.

2.8.3. EMA challenges – current accounting practices

Setthasakko (2010:315) provides a perspective that there is a need to understand EMA, its root causes and barriers and its impacts thereof. Numerous limitations of conventional management accounting systems and practices may hamper the efficiency of collecting and assessing environmental-related data. Such limitations might cause managers to take un-informed decisions which also impacts on the profitability or efficiency of these companies. IFAC (2005:26) clarifies that as a result,

managers may well misunderstand the negative financial consequences of poor environmental performance and the potential costs or benefits of improved environmental performance.

2.8.3.1. Poor communication between accounting and other departments

The accounting, environmental and operations departments have different information regarding their sections. However, this information might be critical for decision-making in other departments. For instance, the environmental department might unintentionally withhold information needed by the accounting department as it needs to be reflected in the financial statements of the company. In the same way, technical employees may be acquainted with the movement of energy, water, and related processes within the company (IFAC, 2005:26). In most instances, environmental and technical employees have limited expertise of how these issues should be posted in the accounting records. On the other hand, accountants have much of the accounting information at their disposal but without ample environmental management information. Hence, accounting personnel are often not providing the required accounting information which environmental and technical personnel might find most useful (Jasch & Savage, 2008: 321).

It is clear that there is a need to improve communication amongst the accounting function as well as other professionals within the business. Until such time that there is effective communication amongst accountants, technical teams and environmental specialists in charge of physical data, development of environmental performance indicators that combine financial and physical measures, and development of environmental management strategies in general, will remain a thought-provoking task (IFAC, 2005:26).

Therefore, the researcher opines that mining companies should understand that their accounting departments ought to corroborate with all internal stakeholders for the purposes of sharing critical information to save the environment.

The above observations on communications led to our 2nd *general* proposition.

- PROPOSITION PG2: Like in most or all spheres in life, communication among stakeholders, systems, etc. is vital.

2.8.3.2. Environmental cost information is often 'hidden' in overhead accounts

Although it has been argued that critical environmental information is often hidden in overhead accounts, this could be attributed to the fact that accountants are usually not aware or well informed about environmental matters in the company. One particularly common way to hide environment-related costs is to allocate them to overhead accounts instead of directly assigning them to the processes or products that created the costs. Whilst overhead accounts are a convenient way to collect costs that may be difficult to assign directly to processes or products, this process may, at a later stage, cause challenges for managers as they might not know where to find the necessary cost information. For instance, some managers might not understand that an account called divisional overhead contains information on environmental permit fees, training costs and legal costs (IFAC, 2011:20).

As advocated by different researchers, the use of overhead accounts for environmental-related costs might also be a challenge whenever overhead costs are allocated back to cost centres (processes, products or services) for pricing as well as other purposes at a later stage. Overhead costs are typically allocated back to cost centres using a variety of allocation bases, such as production volume, machine hours and personnel hours (Jasch, 2006:1195). This may be an incorrect way to assign typical environmental-related costs. An example would be hazardous waste disposal costs based on the production volume will not be accurate, as would product pricing and other decisions based on that information. An assessment of the relative importance of environmental-linked costs and cost-drivers of dissimilar process and product lines might assist companies to determine if the cost allocation bases being used are suitable for those costs (Christ & Burritt, 2013:163, UN 2001).

The researcher is of the view that since environmental costs are often hidden in overhead accounts, it is plausible that mining companies may need to employ other methods such as EMA tools to identify these hidden costs to ensure decisions are made on complete information about the environment.

2.8.3.3. Insufficient tracking of information regarding materials use, flow and financing

Although it is evident that companies generate a large amount of data annually, there is still insufficient information for environmental decision-making purposes. For instance, sometimes the posting of materials purchase information does not allow for clear identification of the amount and value of different categories of purchased materials. For instance, the process of aggregating materials purchase costs and processing costs such as labour into a single cost item. Many production-planning systems calculate materials loss by making use of inaccurate average loss percentages. They may have little to do with the actual losses that occur during production. The employees on-site often have more accurate projections than accounting systems. Few companies can access information relating to their environmental costs, liabilities, and benefits. Most companies claim responsibility for their environmental impacts, however, there is no mitigation as they do not have budgets that are dedicated for environmental issues (IFAC, 2005:26).

Drawing from the preceding argument, the researcher argues that companies in South Africa could realise potential savings if they were to implement EMA as a tool to adequately track information relating to material use, flow and financing. Hence, mining companies could benefit when implementing EMA as a tool to track information regarding material use, flow, and financing by identifying and budgeting directly for environmental impacts. Mining companies may need to make use of information on environmental costs, liabilities, and benefits that might lead to overall cost savings.

2.8.3.4. Environment-related cost information not found in the accounting records

Although Schaltegger and Zvezdov (2015:1334) recognised accounting as an approach for tracking EMA challenges, IFAC (2005:26) considered accounting information systems as a key obstacle to the application and development of EMA systems. Examples include the costs sustained when poor environment performance translates into lost sales to customers who care about environmental issues. Moreover, lost access to markets with environment-related product limitations, and lost access to financing and insurance when shareholders refuse to take on the probable environmental risk linked with a business partnership. These types of costs

can be difficult to project, however, they can be both real and significant to companies' financial growth (IFAC, 2005:26).

The researcher is of the view that companies should structure their accounting function/systems in such a way that they may provide and report on environmental information; for instance, costs incurred due to environmental audits, environmental penalties levied on companies if applicable and environmental outreach programmes. These costs may need to be reflected on the financial statements of the companies.

The following section discusses the pitfalls of EMA.

2.9. PITFALLS OF EMA

Burritt (2005:19) observed that pitfalls of EMA such as environmental regulations impose requirements on companies' liabilities for site clean-ups (remediation). This requires companies to account for environmental damage as well as accounting for relevant clean-up costs. The other pitfall relates to self-regulation whereby companies voluntarily realise the significance of financial implications of corporate environmental impacts. Voluntary acceptance promotes the corporate image of companies as they are deemed responsible by caring for the environment and societies in which they operate. Jing and Songqing (2011:148) argues that the other challenge for EMA is its failure to identify, distribute and measure environmental costs. For instance, environmental costs are usually assigned to projects or consultation fees and not specifically identified and measured as environmental expenses.

The researcher is of the view that companies (coal mining companies) should identify the pitfalls of not employing EMA in mitigating their environmental management costs. This will ensure that they are able to trace activities that attract environmental costs and remedial costs.

The preceding section elaborated on the pitfalls of EMA. However, some of the challenges of this may be as a result of the way in which SLOs were framed (agreement between local communities and companies) as will be discussed next.

2.10. SOCIAL LICENSE TO OPERATE (SLO)

Cognisant of the needs of a community, an SLO is defined as the granting of permission to conduct a business activity and is often complementary to legal

licensing. It implies the level of acceptance that companies and their operations get from government and local communities in which they operate. However, the researcher observes that the SLO definition is limited in that it does not clarify as to how companies should go about engaging local communities in the process of getting permission, namely the SLOs (Komnitsas, 2020:1). However, Nielsen (2013:1585) suggests that different strategies might be needed depending on the dynamics of different communities which companies might be faced with.

Figure 2.10 presents a theoretical framework for assessing the SLO contributing aspects as well as outcomes in the mining sector.

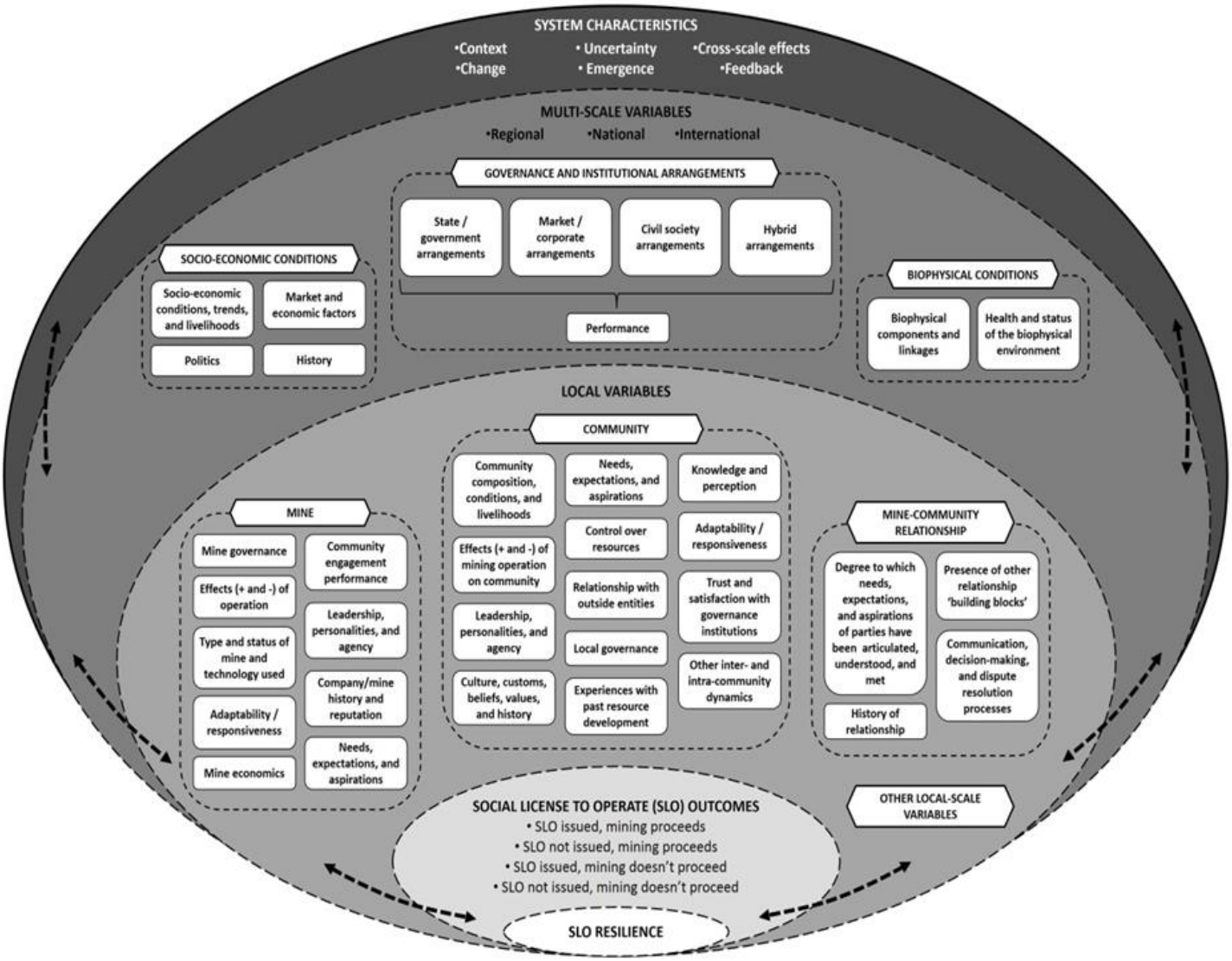

Figure 2.10: A Conceptual Framework for evaluating SLO elements in the mining industry

Source: *Prno and Slocombe (2014:676)*

As depicted in Figure 2.10, the SLO consists of four (4) key parts, namely the structural features, the multi-scale variables, local variables, and SLO effects. Collectively, these portions form part of the theoretical structure for evaluating SLO elements in addition to results within the coal mining business. The framework defines the numerous prospective elements, which might appear to distress SLO effects. In the mid-1990s, the SLO emerged as a response to social challenges. Since then, many actors in the resources sector, including mining companies, civil society and non-governmental entities have adopted the concept (Prno & Slocombe, 2014:672).

2.10.1. Structural features

For companies, it is progressively evident that acquiring a formal licence to operate from government and complying with the stipulated regulations is no longer enough. Instances of mining developments being delayed and even closed doors due to community strikes have been broadly documented. Some characteristics are inherent in all complex adaptive systems. Characteristics principally relevant to the evaluation of SLO determinants and outcomes include context, change, uncertainty, emergence, cross-scale effects, and feedback. For instance, the perspective of each mineral development is unique; hence efforts must be employed to identify the specific variables as well as procedures that are efficient in each instance (Prno & Slocombe, 2014:672).

They also indicate that providing feedback plays a critical role within all SLO systems. Furthermore, local communities should be engaged as part of public participation for resource development and environmental decision-making purposes. This will promote greater public acceptance of the planned mining project and substantively better and more equitable solutions to be devised (Dare, Schirmer & Vanclay, 2014:189; Jartti, Litmanen, Lacey & Moffat, 2020:97).

2.10.2. Multi-scale variables

Multi-scale variables comprise those operational at provincial and countrywide as well as global measures. There are three (3) proposed sub-major classes of SLO-appropriate variables that are operational, namely authority, institutionalised schedules, socio-economic circumstances, and biophysical situations. Control and influential provisions are usually the reputable guidelines and decision processes that

direct choices taken by contestants in the SLO procedure (Prno & Slocombe, 2014:672).

The SLO is regarded as a tool to address the balance of power struggles between local communities and the mining companies. It could be argued that this process entails getting consent through the involvement of relevant authorities and agencies, national and global expert agencies, NGOs and businesses. The SLO operates by working on the interests and beliefs of local communities. Consequently, the SLO as a policy instrument calls for an analysis of its capacity to exercise power in different ways. For instance, when local residents consider a company unethical or a regulatory agency that is opposed to progress might think that their interests are not sufficiently prioritised, neither is protected by these institutions (Behagel & Arts, 2014; Meesters & Behagel, 2017:276; Cesar & Jhony, 2020:1).

2.10.3. Local variables

Although it has been argued that other local scale variables certainly exist, their role is often secondary. For this reason, they are not explained in any sort of detail, however, listed for consideration on a context-specific basis. Mine-related variables that can arise to impact SLO outcomes include the performance of mine management processes, for instance, the mine's ability to address regulatory and social needs. Furthermore, the duty of management within these companies and personalities such as presence/absence of champions is committed to building good rapport with local communities. Community-related variables that can emerge to impact SLO outcomes are numerous and include community members' needs and ambitions (Prno & Slocombe, 2014:672).

The researcher postulates that the success of mining variables, for instance, their relationship with the local communities, depends on what they give back to the community in terms of job opportunities, yet detrimental environmental impacts may raise objections. These objections may be due to the mining operations such as mining, disposal of solid and liquid waste, and emission of gasses. However, mining companies may need to develop rapport with the local communities.

2.10.4. SLO outcomes

SLO outcomes have been described as critical in the commencement of mining activities. To have true public engagement, strong representative processes have to be set up before the commencement of mining activities. These should not only include community representatives but also be inclusive of working groups with a diverse set of actors to strongly represent local ideas and demands (Prno & Slocombe, 2014:672). Moreover, acknowledging stakeholders' experiences and investing in genuine community engagement is key to building trust. However, in instances where the community refuses to issue an SLO for one particular project, it could in fact support mining in alternative formats (for example a different type of the same mine with redesigned facilities and/or reconfigured operational activities (Moffat & Zhang, 2014:61).

The researcher postulates that the view by Moffat and Zhang (2014:61) as well as Prno and Slocombe (2014:672) only offers guidelines but does not provide practical steps as to what mining companies seeking consent should do (how and what) in terms of getting approval.

The above SLO discussions led to:

- PROPOSITION PC6: Coal mining companies need to consider the communities where they want to operate through an SLO and negotiations.

2.11. FACTORS INFLUENCING THE SUCCESS OF EMA

In this section, the factors influencing EMA success is illustrated in the following conceptual framework as portrayed in Figure 2.10. It has been argued that there are various determinants for EMA adoption, for instance a case study in Finland established that Kesko Food also wanted to create a good reputation for being a pioneer in environmental issues. Having taken initiatives to implement EMA, Kesko Food received financial support for having pioneered EMA from a Finnish technology fund (Kumpulainen & Pohjola, 2008:477).

Figure 2.11 portrays factors influencing EMA success.

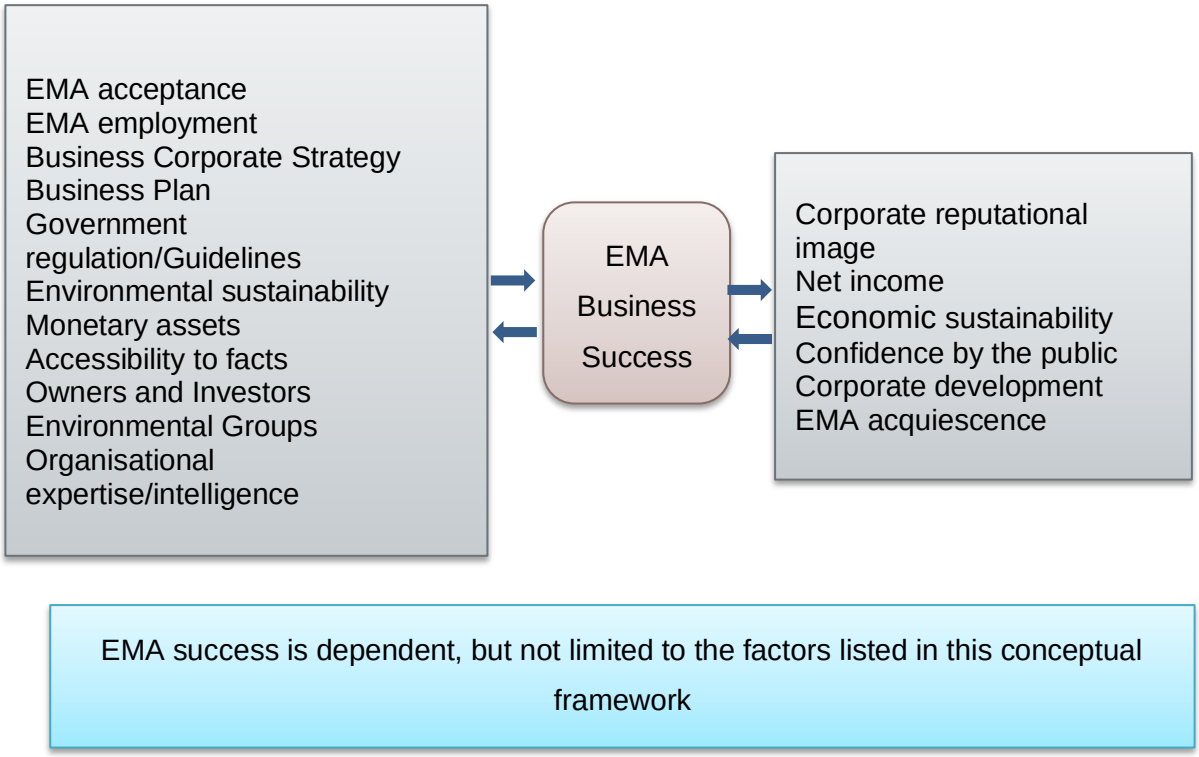

Figure 2.11: Factors influencing EMA success

Adapted: *Jasra, Khan, Hunjra, Rehman and Azam (2011:278)*

Figure 2.11 demonstrates that companies need to adopt EMA before implementation; the company's business strategy must incorporate EMA in its business plan for it to become policy. Government policy or legislation compels companies to implement EMA to achieve sustainability. Environmental groups, for example, can also influence companies to adopt and implement EMA. Lastly, EMA business success can be evident in a company when there is an improved business reputation, net profit, and business sustainability (Jasra *et al*. 2011:278). The researcher postulates that the preceding factors have a limitation in that they do not address how EMA success may be achieved. Furthermore, they do not indicate what challenges could be experienced in the process of implementing EMA and how these challenges can be mitigated (Zandi & Lee, 2019:342).

In the previous section, factors influencing EMA success were explored hence the following section discusses the link between EMA adoption as well as implementation.

The following section investigates EMA adoption and EMA implementation, the benefits of EMA specifically for the coal mining industry, discusses the EMA gaps,

EMA principles and the possible reasons for non-compliance by coal mining companies.

2.11 THE LINK BETWEEN EMA ADOPTION AND EMA IMPLEMENTATION

This section of the literature review discusses the existing literature as advocated by previous scholars and follows two (2) main approaches; the determinants of EMA adoption and implementation; and the barriers of EMA adoption and implementation.

2.11.1 Conceptual framework of EMA adoption

Whilst EMA processes are utilised to ascertain a company's environmental effects for familiar judgement, it follows that EMA procedures may support companies to improve their green performance. The relationship between environmental and financial achievement remains contentious. Previously, environmental success was considered a deterrent to the effectiveness of business performance. Companies are particularly faced with difficulties as their operations might attract higher environmental costs. Besides, costs for compliance to environmental guidelines could additionally cripple their financial performance (Schaltegger & Wagner, 2005:46).

Companies sustain higher environmental costs hence they have an obligation to seek production processes that might decrease environmental costs. Moreover, by capitalising in cleaner production processes, companies will be able to stay ahead of their competitors to achieve competitive advantage. Furthermore, they will have the proficiency to invent and ascertain first-hand systems and/or technological expertise for environmental production and to discover the company's effectiveness as a long-term objective (Ntalamia, 2017:5).

Figure 2.12 portrays a conceptual framework of EMA adoption.

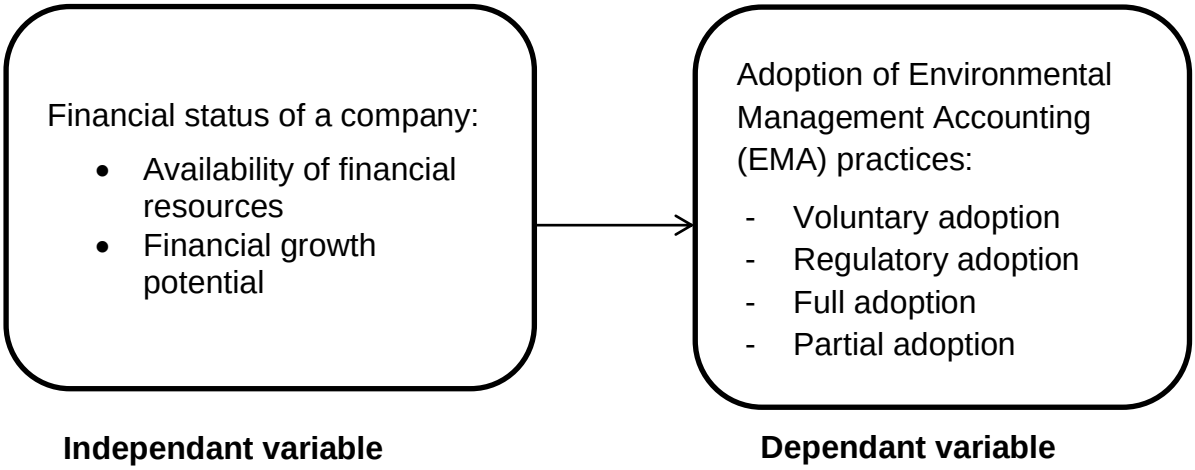

Figure 2.12: Conceptual framework of EMA adoption

Source: *Ntalamia (2017:5)*

As depicted in Figure 2.12, the researcher postulates that the independent variables will indicate whether the adoption and employment of EMA is voluntary and regulatory; for instance, forced by government rules or directive, full adoption and partial adoption. Moreover, the availability of an environmental management budget will ensure that companies adopt and implement EMA. This will be based on the reasoning that the financial implications have been catered for. Therefore, financial resources (independent variable) is dependent on the availability and full adoption of EMA (provision for the budget) which is the dependant variable. Partial adoption means that companies will partially implement EMA and full adoption always infers that the companies with fully employ EMA practices.

The researcher postulates that this implies that management of companies have to consider independent variables such as the current financial status of the company and the availability of financial resources such as capital assets. In addition, companies should ensure that they are financially sustainable so that they are not limited in terms of implementing EMA tools.

2.11.2 Determinants of EMA adoption and implementation

Regulatory compliance and legal certainty, as presented by Morrow and Rondinelli, (2002:170) have been regarded as primary motivations for the adoption and implementation of EMA. The argument presented by Muza and Magadi, (2014:84)

shows that the adoption of EMA could, in most instances, be influenced by regulatory requirements and pressure. However, Sarker and Azam (2011:397) established that the adoption of EMA in Australia was due to social structural influences and company contextual influences, which motivated the development of EMA for waste management. Social system-based theories such as legitimacy, stakeholder and institutional theory seem relevant in the adoption and implementation of EMA. For instance, production companies, and particularly the accountants within, need to be exposed to the benefits of having an efficient environmental cost management system that fully internalises and completely tracks their environmental costs (Holt & Ghobadian, 2009:948; Garzella & Fiorentino, 2014:82).

It is, therefore, significant that the small and medium enterprises (SMEs) have responded to environmental challenges and progressed because of encouragement and pressure from stakeholders. However, in most instances, the adoption of EMA was because of a directive from senior management and shareholders. This could be achieved by integrating EMA into corporate policies and key performance indicators (KPIs) (Bagur-Femenias, Llach & Alonso-Almeida, 2013:55; Ramakrishnan, Haron & Goh, 2015:43).

Jalaludin, Sulaiman and Ahmad (2011:540); as well as Qian, Burritt and Monroe (2011:93) established that there are different reasons that determine the adoption of EMA. However, there have been similarities on the adoption of EMA from different countries. A study by Saeidi and Sofian (2014:30) demonstrated that most companies adopt EMA due to government policies and sociological orientation. For instance, in Malaysia, it was established that educational bodies such as accounting companies, policymakers and the Inland Revenue Board influenced the adoption EMA by manufacturing companies. In Australia, it was found that the adoption of EMA was due to encouragement by the respective communities and the need to demonstrate social responsibility.

2.12. RELEVANCE OF ENVIRONMENTAL COSTS

Environmental costs are rarely disclosed separately unless they represent an exceptional item, and there is often no reason to treat such costs in a different way from other costs. The recognition of environmental liabilities may require greater clarity in identifying and defining the underlying costs since they often involve uncertainty

regarding their timing and measurement. The disclosure of such information, together with an appropriate explanation, is likely to be expected by users in view of the increasing importance of the environment. Where environmental costs are disclosed, the way in which such costs are identified should also be explained to ensure that comparisons between companies do not result in misleading conclusions (Ibanichuka & James, 2014:41).

The relevance of environmental costs as presented by Burritt (2004:13) is dependent on a variety of considerations, and these include:

- the management function;
- decision-making requires future environmental costs of different alternatives;
- control requires a comparison between expected and actual environmental costs;
- second the specific decision being made: capital investment, capacity location or closure, product or process design;
- the role of the manager in the value chain, design or production;
- the responsibility level of the manager: top manager or purchasing manager; the appraisal system: individual rewards based on the use of achieving budgeted environmental cost as a measure of individual performance (Burritt, 2004:13).

The researcher postulates that EMA adoption may depend on the evaluation of both the costs and expected capital gains of the relevant coal mining companies. According to the determinants of EMA adoption and implementation, management of a company may need to consider the benefits of capital investment to the cost of EMA implementation.

2.12.1. Classification of environmental costs

Kim (2002:56) suggests a two-way classification of environmental costs. The first criteria that relate to the types of environmental activities and environmental costs are classified as follows:

- **Pollution prevention costs**

These are costs incurred to prevent pollution at the source. Examples include additional materials costs to switch to more environmentally friendly raw materials, and additional energy costs to switch to cleaner energy (Kim, 2002:56).

- **Pollution treatment costs**

Once generated, pollutants should be treated so that they do not contaminate the natural environment. Therefore, the costs which are incurred to eliminate or reduce environmental impacts of pollutants that are generated in the production process are called pollution treatment costs. Examples include wastewater treatment costs, the operating costs of an incinerator, and depreciation costs of treatment facilities (Kim, 2002:56; Burritt, 2004:13).

- **Environmental management system (EMS) costs**

EMS costs are indirect environmental costs incurred to design, establish, implement, monitor, evaluate and improve the EMS. All costs related to ISO certification belong to this category. This includes costs incurred to carry out life cycle assessments (LCA), environmental performance evaluation (EPE), environmental audits and environmental labelling, and costs associated with educating employees (Kim, 2002:57).

- **Stakeholder costs**

These are costs incurred in the process of building good rapport with external stakeholders. These include investors, creditors, regulators, communities, consumers, and environmental activity groups. By maintaining good relations with its stakeholders, companies can avoid unnecessary downtime such as strikes. Examples include costs of monitoring and reporting to regulators, sponsoring the activities of environmentally orientated NGOs, and financial support to local community events (Kim, 2002:57).

- **Environmental damage costs**

When waste materials are discharged into the environment without adequate prior treatment, they are likely to pollute the environment. Therefore, environmental damages should be restored and any damage to health, life and property should be compensated. Examples include fines and penalties for non-compliance with

environmental regulations, and compensation to third parties because of loss or injury caused by past environmental damages and pollution (Kim, 2002:57).

2.12.2 Classification of environmental activities and environmental impacts

Table 2.3 classifies environmental activities and the associated environmental impacts (Kim, 2002:57).

Table 2.2: Classification of environmental activities and environmental impacts

Environmental activities	Environmental impacts
Pollution prevention costs	Air pollution prevention or treatment costs
Pollution treatment costs	Water pollution prevention or treatment costs
Environmental management system costs	Solid waste reduction or disposal costs
Soil pollution due to mining activities	Soil contamination prevention or remedial costs
Environmental damage costs	Sustainable resource conservation costs
Noise pollution costs due to blasting or machinery	Other costs including those to prevent noise, odours, etc.
Stakeholder costs	Compensation costs to affected communities or stakeholders

Source: *Kim (2002:56)*

Table 2.3 demonstrates that for every environmental activity, there are relevant environmental impacts and associated costs. These costs can be averted to achieve environmental benefits if ever companies consider the adoption and implementation of EMA as well as material flow cost accounting (MFCA).

2.12.2. How to define and calculate environmental costs

The environmental protection costs include all activities taken for legal compliance, compliance with own commitments or voluntary. When calculating a company's internal environmental costs, one should look not only at expenses of environmental protection. The concept of waste has a double meaning, as waste signals inefficiency. The costs of wasted materials, capital, and labour should be totalled in order to arrive

at total corporate environmental costs as a sound basis for further calculations and decisions.

Table 2.4 demonstrates how to calculate corporate environmental costs.

Table 2.3: Calculating corporate environmental costs

	Environmental Protection Costs (Emissions, Treatment and Pollution Prevention)	
+	Costs of wasted materials (including water and energy)	R85,000.00
+	Costs of wasted capital and labour	R165,000.00
=	**Total corporate environmental costs**	**R250,000.00**

Adapted: *Jasch (2002:42)*

It can be seen from Table 2.4 that the total corporate environmental costs are R250,000.00. The cost of wasted capital and labour is more than that of wasted materials including water and energy. In application to this study, coal mining companies should be able to quantify their environmental footprint to be in a position to calculate their corporate environmental costs. This will enable companies to identify areas of wasteful expenditure to realise savings.

2.12.3. Environmental benefits

When environmental costs result in the elimination or decrease of environmental impacts, or in the improvement of environmental performance of a company, the environmental benefits should be matched with the corresponding costs to the extent possible. The scope and the reporting period of environmental costs can be linked to environmental benefits. These environmental benefits can be measured in either physical or monetary units hence this provides a link to MFCA. While environmental burdens are measured, and changes therein are best measured in physical units, economic benefits from environmental measures taken by mining companies, such as revenues and cost savings or avoidance, are best measured in monetary units (Kim, 2002:57).

2.12.4. EMA as a system to support management informed decisions

It has been argued that if sustainability initiatives are caused by the manager's own decisions, managers needed KPIs from EMA to monitor their performance. EMA would be more likely to be a continuous information management system that supports internal reporting purposes. Different approaches to EMA are mostly directly distinguished regarding their differing emphasis. Firstly, on the content of the activity, for instance, the balance between monetary and non-monetary data; secondly, the principal purpose, in particular the well-established accounting distinction between primary target audiences – how far the primary objective is internal decision support for management or external reporting (Tsui, 2014:3).

2.13. IMPLEMENTING EMA IN A DAY

The presentation by Jasch (2006:1195) shows that the implementation of EMA may be conducted in a day. The most essential task is to ensure that all relevant and significant costs are considered when making business decisions. In other words, corporate environmental costs are a subset of the bigger cost universe that is necessary for good decision-making. Environmental costs are part of an integrated system of materials, energy, and money flows through a company, and not a separate type of cost. Doing EMA is simply doing better, more comprehensive management accounting (MA) while wearing an environmental hat that opens the eyes for hidden costs. Therefore, the focus of material flow accounting is no longer assessing the total environmental costs, but on a revised calculation of production costs based on material flows including energy and water.

The researcher postulates that companies should strive to implement and adopt EMA to attain savings as well as to preserve the environment.

The foregoing EMA discussions linked with stakeholder interests led to our 1st linking or *association* proposition:

- PROPOSITION *PA1*: There is a direct association between the purpose and environment (stakeholders) in terms of providing stakeholders with EMA information.

2.14. BARRIERS OF EMA ADOPTION AND IMPLEMENTATION

It has been argued that stringent government legislation may hamper EMA adoption. In most instances, certain strategic decisions can be imposed by government authorities through penalties or threats, for instance, government legally enforcing environmental standards. Government regulation, including inspections and enforcement actions, is one of the most important factors affecting companies' decisions-making process (Zhang, Bi & Liu, 2009:211). In other instances, the accounting department plays a significant role in providing relevant information for environmental management and reporting purposes. This is because most environmental information is produced by other company areas, rather than by the accounting function.

In other words, accounting was considered as irrelevant to the process of providing environmental information. Therefore, accounting did not respond to changes in design archetypes, sub-systems, and interpretive schemes nor was it a driver (Da Sylva Monteiro & Guzmán, 2010:431). Martin and Barnard (2013:7) suggest that although the coal mining companies are striving to employ more women into the industry, women are faced with oppressive behaviour from the male employees. This is based on the notion that the coal mining industry is still regarded as male dominated.

The foregoing section indicated the barriers for the adoption and implementation of EMA hence the following section will dwell on the benefits of EMA.

2.15. THE BENEFITS OF EMA

EMA is a closely linked process to activity-based costing (ABC) and environmental performance, and well-designed and implemented EMA tools can assist in ensuring better internal management decision-making. For instance, EMA may be utilised for investment appraisal, cleaner production, improving environmental-efficiency, and calculating savings within companies as a basis for external accounting and reporting (Jasch, 2006:1194). On the internal side, EMA helps the company to effectively track and manage its physical and associated financial resources, and to identify opportunities for cost savings (Ferreira, Moulang & Hendro, 2010:923).

The benefits of employing EMA include efficiency improvements and better decision-making based on consistent information systems or strategic advantages, for instance,

by evaluating the implications of new regulations such as emission trading. Even though the uses and benefits of EMA are numerous, they can be organised into three (3) broad categories, namely:

- compliance which implies that EMA supports environmental protection through cost-effective compliance with environmental regulation and self-imposed environmental policies;
- eco-efficiency which implies that EMA supports the simultaneous reduction of costs and environmental impacts through efficient use of energy, water and materials in internal operations as well as final products;
- strategic positioning meaning that EMA promotes the assessment and application of cost effective and environmentally sensitive programs for ensuring a company's long-term strategic position (Jasch, 2006:1194; Ferreira *et al.*, 2010:923).

Therefore, EMA provides cost savings and decreased environmental effects, and as a result, mining companies may need to consider adopting and implementing EMA.

2.16. MATERIAL USAGE IN THE PRODUCTION PROCESS

A pro-active environmental management searches for the reciprocal compatibility between the business and its environment, with respect to competitive opportunity. Nevertheless, it requires changing the way we think: recognition of the larger context, acceptance of uncertainty and uncertainty of a company's potential impact, challenges of the world view, emphasising inclusion of more external stakeholders' view and cost of externalities (Bracci & Maran 2013:541).

Figure 2.13 portrays how production activities affect the environment.

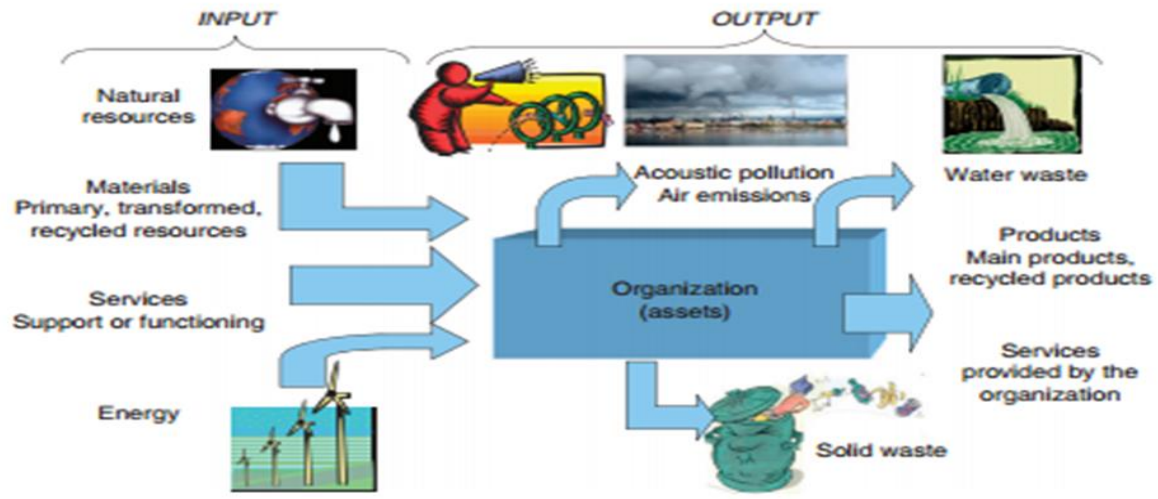

Figure 2.13: How production activities impact the environment

Source: *Bracci and Maran (2013:542)*

Based on Figure 2.13, the inputs required to generate the company assets include natural resources, materials in terms of primary, transformed or recycled resources, services support or functioning, and energy. The outputs generated include company assets (benefits), however, the negative outputs include solid waste, acoustic pollution, and air emissions. Other wastes from the company include water waste (discharge), main products, recycled products, and services provided by the company. Therefore, companies may need to rethink ways in which they conduct business considering environmental compliance.

In the previous section, EMA processes are utilised to ascertain the coal mining industry's' environmental impacts. It follows that EMA tools may support companies to improve their environmental performance. Therefore, companies may need to understand environmental costs and be able to benchmark on possible savings. The following section discusses the EMA tool material flow cost accounting (MFCA).

2.17. TOOLS OR METHODOLOGIES: MATERIAL FLOW COST ACCOUNTING

This section deliberates on the origins of MFCA, defines and clarifies the benefits of MFCA, non-product output and corporate mass balance, as well as life cycle cost (LCC) analysis.

2.17.1. Origins of MFCA

The assertion by Wagner (2015:1255) to understand MFCA, its source and background should be defined. MFCA, as it surfaced in the International Organization for Standardization, ISO14051 standards appeared as a rational significance regarding projects of environmental nature in the manufacturing companies in Kunert, Southern Germany during the late 1980s and the early 1990s. The elementary perception of MFCA was not just an impulsive development devoid of any preceding history. Some decisive fundamentals, for instance, the idea of input/output mass balances or evaluating physical movements of manufacturing in material and price terms, had previously been deliberated in Germany around the 1920s as well as 1930s. However, Schaltegger and Zvezdov (2015:1333) suggest that MFCA is perceived as a methodology that has been directly and indirectly influenced from several perspectives. Material flows and the environmental significance of dematerialisation have received consideration from environmental resources, cleaner production and management accounting.

It is suggested that MFCA attempts to capture the idea of justice amongst societies and generations, specifically the equal privileges of most people to environmental resources.

2.17.2. Defining MFCA in the context of EMA

MCFA brings about a price estimation of a physical loss by means of production cost information, besides being utilised for management accounting purposes to improve material efficiency. The decrease of physical loss concurrently reduces environmental costs, reducing input material or the total energy utilised might assist to build a lower carbon supply chain (SC). MFCA is consequently not only a price regulator, but also an environmental effect. MFCA has been defined as a process of determining the movements of stock materials in the production process in both physical and monetary units (Schmidt & Nakajima, 2013:360).

MFCA is a tool that provides an opportunity for companies to capture waste cost information accurately beyond that provided by conventional management accounting systems. Waste generated by companies impacts on both costs and the environment in numerous ways. For instance, lost income through a combination of lost materials

and disposal costs and decreasing the amount of wasted materials is an effective approach to improving resource efficiency. EMA tools such as MFCA may be utilised to capture and draw investors' attention to the full costs of waste (Fakoya & van der Poll, 2013:136; Dierkes & Siepelmeyer, 2019:491).

As argued by Chompu-inwai, Jaimjit and Premsuriyanunt (2015:1352), MFCA provides detailed and in-depth waste cost information by analysing flow of materials and energy in a production process. Accountants naturally have a direct interest in managing and reducing business environmental costs to increase profit. In most instances, challenges often arise because environmental costs are hidden in overhead accounts. This means that decision-makers have in the past used inaccurate environmental or waste cost information to make informed decisions. Therefore, successful implementation of EMA is dependent on the existence of logical support from relevant government institutions.

The above discussion leads to the following content proposition:

- PROPOSITION *PC7*: Material Cost Flow Accounting (MCFA) is an important management accounting tool to be used in EMA.

2.17.3. Reducing waste through operational efficiency

It has been argued that MFCA regards waste as a negative product and allocates material and processing costs to it. Wastewater and effluents are considered as process waste that is assessed as economic losses. This is utilised to draw managers' attention to wastefulness and inefficiencies in the production line. This should encourage managers to devise cost saving measures and ensure that company processes are generating less waste. MFCA can be applied to large, small or medium sized companies. The issue of decreasing operating resources and energy inputs was deliberated as a mutual objective of economic environmental interests. Primary methodologies with flow cost accounting were followed. Flow cost accounting proved to compute and assess all materials and energy movements of a distinct manufacturing process, firstly in kgs, also linking these to the current cost accounting system (Fakoya & van der Poll, 2012:9786; Dekamin & Barmaki, 2019:459).

Material cost accounting was assumed as a comparable method designed to calculate the costs accumulated in the outstanding materials from industrial uses. This, too,

worked on the foundation of amounts articulated in kgs. Moreover, to the costs of disposal, the remaining material costs also consist of physical value subsequent from the value of unprocessed materials, costs of storage, treatment of the outstanding materials, and environmental operations (Nakajima *et al.,* 2015:1303).

The discussion on waste leads to:

- PROPOSITION *PC8*: Coal mining companies should have proper systems in place to determine wasteful activities and a budget allocated to mitigate environmental degradation.

2.17.4. Non-product output

The purpose of material flow balance as illuminated by Reibstein (2009:832) is to fully understand how much of what is put into the system becomes a product and how much NPO. Understanding NPO is the best way to manage environmental issues. The creation of waste or NPO is a sign of wasteful production. Therefore, material flows are essential not only for the assessment of environmental costs but also for the production-related cost valuation.

However, an EMA system might provide information that could be utilised for channelling informed decisions towards the adoption of cleaner production processes. This means applying new technologies to decrease these costs. An EMA system provides companies with valuable information concerning the value of the purchased NPO and makes it probable to track and trace instances where NPO is created (Domil, Pereş & Pereş, 2010:720). Companies can therefore use this information to suggest ways to increase the efficiency of material use that will minimise environmental impacts and improve economic performance. The purpose of material flow is to understand how much of what is put into the system becomes a product, and how much becomes NPO. Understanding NPO is the best way to manage environmental issues (Hyršlová, Vágner & Pálasek, 2011:5).

A correct balance regarding the flow of materials, figures equally for the resources used and the succeeding quantities of products, cast-off materials and discharges should be established. All materials are evaluated in physical units in the form of mass (kg, tonnes) or energy (MJ, kWh). The acquired input is compared with the produced amounts and the results of the discarded material and releases. The goal is financial

and environmental improvement in the efficiency of handling resources (Jasch, 2003:673).

Figure 2.14 portrays the corporate input-output (mass balance).

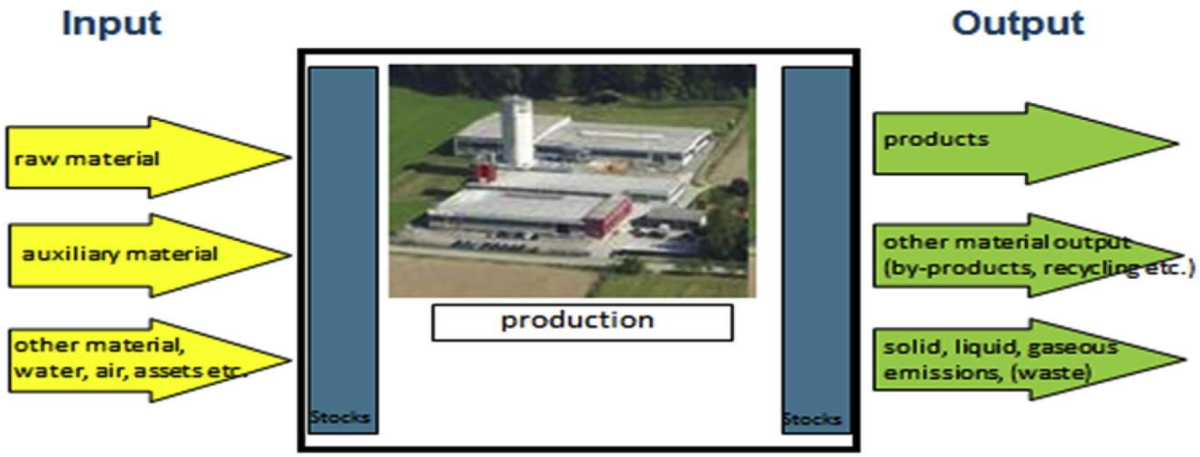

Figure 2.14: Corporate input-output (mass balance)

Source: *Wagner (2015:1256)*

For production to occur (Figure 2.14), different inputs are needed as inventories such as purchased raw, auxiliary, and other materials that include water, air, and assets such as plant machinery. The production process will result in an output such as products that may be sold to generate profit or loss. The other material output includes by-products, recycling materials; solid or liquid waste, gaseous emissions and other waste.

2.17.5. Corporate mass balance

The explanation by Wagner (2015:156) suggests that the total business mass equilibrium remained centred on the decrees of thermodynamics. Theoretically, this implies that input material or energies that go into a business are tracked in precise (stoichiometric) volumes; moreover, gathering input material or exiting the business as output material. However, Wan, Ng, Ng and Tan (2015:604) contended that in a normal production process, the required quantity of energy types, raw materials, intermediate material from processes or recycled wastes from processes are fed into another process. This is to produce desired amounts of intermediate material for process and the desired amounts of desired products. In the interim, a total amount of wastes is produced during the process (Huang, Chiu, Chao & Wang, 2019:27).

Consequently, Doorasamy and Garbharran (2015:41) argue that MFCA analysis makes it possible to identify the complete costs which allow for technical processes that can be applied, thereby reducing material loss. It is assumed that companies that implemented MFCA can identify material losses to be expressively higher than they had previously comprehended. Therefore, MFCA may present the opportunity for companies to strive towards cleaner production and achieving their targets of lower material losses and cost reduction.

The researcher postulates that the preceding literature established that the physical quantities are quantified under PEMA and the financial values as MEMA. This is based on the reasoning that sourced physical components or resources are required as input material to the production process. This will lead to products which might be transformed into cash to generate revenue (profit).

The MFCA process is narrated in Figure 2.15 and demonstrates the relation between the physical quantities and the financial values (cost).

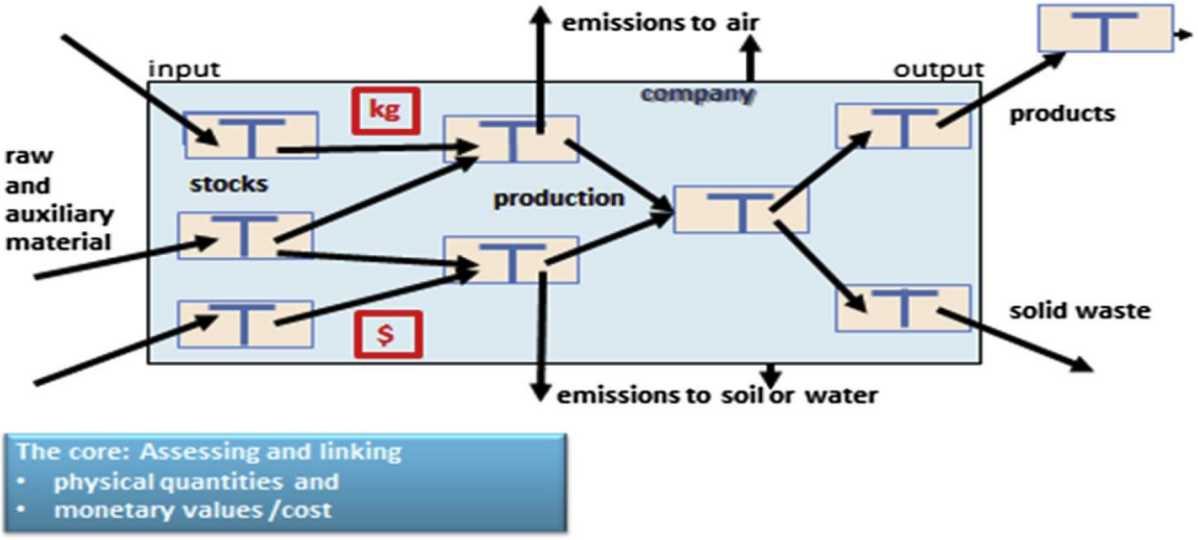

Figure 2.15: The link between physical quantities and monetary values

Source: *Wagner (2015:1257)*

Figure 2.15 depicts a similar scenario that was demonstrated by Pan *et al*. (2010:561) regarding the conceptual model (Figure 2.5) for mining operations in terms of how the mining operations impact humans, flora and fauna. This is due to raw and any supplementary materials being credited to the production process. This creates pollutants or emissions into the air and ground. The outputs from the manufacturing process include the final products and the solid or liquid waste (Wagner, 2015:1257).

In principle and application to this research, companies should be able to quantify costs of their inputs in comparison with their outputs (profit). This will determine their level of profitability.

2.17.6. Benefits of MFCA

When MFCA was evaluated at Canon, a Japanese company on the manufacturing of their lenses with specific focus on the effectiveness of their production lines with regard to the crushing process, 20% to 30% of costs were established to be fundamentally NPO costs. MFCA enabled companies to identify the loss of resources that were hidden within the manufacturing processes. These savings were credited to efficient use of materials leading to improved economic and environmental performance (Burritt & Saka, 2006:1273; Tran & Herzig, 2020:17).

Environmental efficiency may be considered as a process, which integrates information relating to both financial and physical aspects regarding the environmental performance of companies. It was established that the MFCA methodology exposed 10% of total production charges that were triggered by material losses in the Philippines. Peanut skins (6.3%) and rotten peanuts (2.4%) in boiling and peeling contributed the most to these preventable costs, followed by broken peanuts (0.8%) in cold and selecting procedures (Herzig, Viere, Schaltegger & Burritt, 2012:111; Zou, Zeng, Zhou & Xiao, 2019:625).

ISO14051 (2011) serves as a guiding principle by linking monetary and information on physical units. Companies familiar with comparable ISO quality, environmental management doctrines, and correlated technology might be used to reduce the level of complication and compliance managers into executing MFCA with its prospects for advanced growth in environmental and monetary performance (Rieckhof, Bergman & Guenther, 2015:1276).

When companies are faced with deteriorating natural resources, they should extensively increase their material efficiency. To achieve efficient usage of natural resources, MFCA is a supporting instrument. This understanding should filter down to all functional levels through the employment of management control systems (MCS). Accordingly, companies should contemplate implementing MFCA as an instrument to reduce costs and eliminate unnecessary waste (Christ & Burritt, 2016:8).

Note how the above MFCA discussion supports PROPOSITION *pC7* (MFCA aspects).

Furthermore, the discussion on standards leads to:

- PROPOSITION *PC9*: ISO standards play an important role in environmental regulations as well as the tools used in EMA aspects, e.g. MCFA (refer also to *PROPOSITION PC7.*)

2.17.7. Analysis of MFCA in the context of EMA

Kokubu, Kitada and Mouritsen (2012:3) established that MFCA as a tool of EMA quantifies the flows and inventories of materials within the production process in both physical (PEMA) and monetary (MEMA) units. MFCA is regarded as an efficient tool that can assist companies to quantify their waste and their profitability. An MFCA leader (Figure 2.16) is positioned as a marketer at the centre of the supply chain (SC) system to manage MFCA. This leader manages interaction between service providers. Moreover, it manages consumers to address intermediate to long-term matters, which need a certain extent of collaboration including period to decide. The MFCA champion endorses and provides the implementation of MFCA amongst contractors as well as clients.

Figure 2.16 depicts the positioning of an MFCA champion in a low-carbon supply chain.

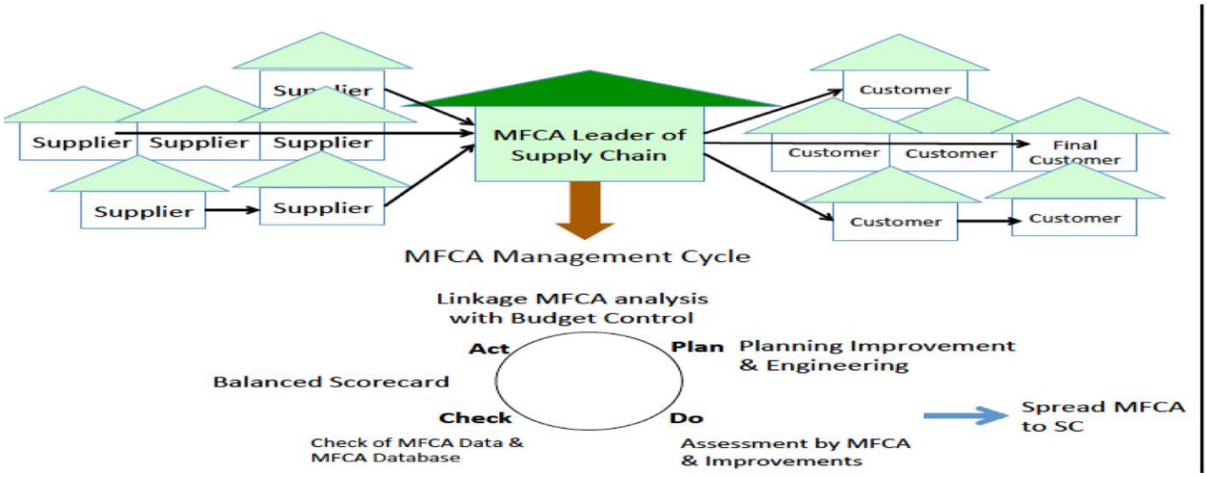

Figure 2.16: Positioning of an MFCA champion in a low-carbon SC

Source: *Nakajima et al. (2015:1304)*

Figure 2.16 demonstrates that apart from the fact that the MFCA leader is central to the SC network, the MFCA leader links the MFCA management cycle in terms of

planning improvement and engineering, doing assessments by MFCA and improvement, checking of MFCA data and MFCA database, and acting on linkage to MFCA analysis with budget control. This entire process is extended to the whole SC network through knowledge sharing.

The plan-do-check-act-cycle placing of an MFCA frontrunner in a lower-carbon SC MFCA has been argued as the planning stage that involves four (4) steps. That is, involvement of management, determination of necessary expertise, categorisation of a periphery, as well as a stretch of time. The doing stage involves three (3) processes, namely the forecasting of input material as well output resources for each capacity division, quantification of the substantial flows in physical units, and computing of physical streams in financial elements. The checking stage involves two (2) processes, namely communication of MFCA results and MFCA data summary and interpretation. Lastly, the acting stage involves only one (1) process, which is the identification and assessment of improvement opportunities (Schmidt, Hache, Herold & Götze, 2013:234). Researchers have argued that an EMS is founded on the operational needs of a business. The emphasis is placed on the company's manufacturing practices including the overall controlling structure – not in the release of polluted air, effluent, solid and hazardous discarded material, as environmental guidelines generally do. An EMS reduces these emissions, effluents, and other wastes by improving a company's management processes so that less pollution and waste are generated (Bendavid-Val & Cheremisinoff, 2003:1).

The environmental management policy declares the company's basic environmental values and establishes guidelines that govern the design and operation of the rest of the EMS. However, as soon as the implementation plan is initiated, the company monitors its environmental performance indicators of concern and systematically tracks and evaluates implementation progress toward achieving the targets. Through a significant economic relationship with suppliers, major customers may hold an important competitive advantage (Gosman, Kelly, Olsson & Warfield, 2004:118).

In categorising environmental costs, EA terminology uses alternative terms, for instance, full, total and true, besides life cycle. This is to emphasise that the constraint of the outdated approaches was incomplete as it overlooked significant environmental costs including potential cost savings and revenues (Nataraj & TG, 2015:49).

Table 2.4 shows the examples of environmental costs from the literature that may be incurred by companies.

Table 2.4: Examples of environmental costs experienced by coal mining companies

POTENTIAL HIDDEN COSTS		
REGULATORY	**UPFRONT**	**VOLUNTARY (Outside Compliance)**
Announcement	Inspection of site	Public liaising
Recording	Clearing of site	Promotional
Monitoring/testing	Authorising	Monitoring/testing
Modelling research	Research and Design	Developmental initiatives
Control	Engineering and commodity sourcing	Auditing
Keeping of records		Qualifying Suppliers
Strategies	Fitting	Reports (e.g. yearly environment reports)
Examinations	**Conventional costs**	
Establishing	Investment assets	Indemnity
Tagging	Resources	Scheduling
Readiness	Labour	Viability research
Safety gear	Suppliers	Mitigation
Medical surveillance	Utilities	Reconditioning
Environmental	Structures	Environmental studies
Indemnity	Salvage value	Research &Design
Spill response		Other environmental projects
Storm water		Designing
Management	Back-End	Fiscal support to environmental groups and researchers
Waste management	Termination	
Disposal of inventory	Discharging	
Financial assurance	Discarding of inventory	
Taxes/fees	Post-closure maintenance	
Pollution control	Surveying the site	
	CONTINGENT EXPENDITURES	
Forthcoming compliance costs	Mitigation & control	Legal disbursements
Penalties/fines	Property destruction	Natural resource indemnities
Mitigation & control	Individual harm indemnity	Economical loss indemnities
Corporate Image	Rapport with expert staff	Rapport with moneylenders
Customer Rapport	Rapport with employees	Rapport with local societies
Rapport with shareholders	Rapport with providers	Rapport with controlling bodies
Rapport with underwriters		

Source: *EPA (1995:9)*

It is evident that uncovering and recognising environmental costs associated with a product, process, system, or facility is important for good management decisions (EPA, 1995:7). Achieving goals such as reducing environmental costs, increasing revenues, and improving environmental performance requires paying attention to current, future, and potential environmental costs. How a company defines an environmental cost is dependent on how it intends to use the information, for instance, cost allocation, capital budgeting, process/product design, other management decisions, and the scale and scope of the exercise. Moreover, it may not always be clear whether a cost is environmental or not. Some costs fall into a grey zone or may be classified as partly environmental and partly not. Whether or not a cost is environmental is not critical; the goal is to ensure that relevant costs receive appropriate attention. However, EMA is the way that companies account for the material use and environmental costs of their business (Bennett & James, 1998:29).

Based on the preceding arguments, MFCA may be used to reduce the amount of waste to achieve profit.

The above discussions led to a *content* proposition:

- PROPOSITION *PC10*: The subdivisions of EMA, namely, MEMA and PEMA have important roles to play in addressing EMA considerations (refer also to *PROPOSITION PC5.*)

And two (2) *association* propositions:

- PROPOSITION *PA2*: There is a direct association between the subject field (PEMA and MEMA) as well as the environment (stakeholders). For instance, stakeholders will be provided with physical and monetary information.
- PROPOSITION *PA3*: There is a direct link between the EMA subject field and tools and methodologies, e.g. MFCA.

The following section explores life cycle cost analysis.

2.17.8. Life cycle cost (LCC) analysis

LCC has been defined as a method of calculating all the costs relating to the materials (equally comprising materials and services) induced over its life cycle. It is a systematic instrument which fits within the classification of the life cycle methodologies (Huppes, van Rooijen, Kleijn, Heijungs, de Koning & van Oers, 2004:4). The LCC

technique integrates prevalent financial information such as cost data which shows the metrics of life cycle processes. LCC includes all the costs and expenses that somebody has invested. For example, the total cost that the producer devoted to a certain amount of money or provided a bespoke service during the life cycle of that product. Several conventional cost-accounting systems influence inappropriate project choices regarding environmental costs. One of the major challenges is that environmental charges are not included in the conventional accounting system. Therefore, LCC has been designed to address this predicament. Conversely, this may not be an appropriate decision since LCC was not designed from an environmental viewpoint (Gluch & Baumann, 2004:571; Tamburini, Pedrini, Marchetti, Fano & Castaldelli, 2015:2916; Kaewunruen, Sresakoolchai & Peng, 2019:16).

LCC has been used as a tool to classify different investment decision-making alternatives, both short- and long-term. However, an additional objection relates to the limitations of the LCC system. The main difference between environmental resources, material calculations and LCC is that the LCC method has a wider life cycle position (Gluch & Baumann, 2004:571; Bierer, Götze, Meynerts & Sygulla, 2015:1292). This is based on the thinking that it not only contemplates investment costs, but also reflects operating costs during the projected life term of a product. LCC involves precise financial matters directly or indirectly stimulated by the material process. This entails the input of unprocessed materials grounded on the processes from upstream, which are critical in understanding the product. All the costs related in every stage of the life cycle of the products must be inclusive of the final assessment of the services or products as part of the sourcing costs for the subsequent consumer (Testa, Iraldo, Frey & O'Connor, 2011:579).

The preceding section demonstrated that MFCA and LCC can be used as EMA tools to quantify waste to achieve savings or profit in the production process, leading to a *content-driven* proposition:

- PROPOSITION *PC11*: Life Cycle Costing (LCC) is an important tool to be used by the coal mining industry in material analyses.

And the next *association*:

- PROPOSITION *PA4*: There is a direct association between the purpose and tools (methodologies), e.g. the flow of LCC or MFCA information to achieve a purpose.

The following section delves on the regulatory environment.

2.18. REGULATORY ENVIRONMENT

Stigler (1971:292) challenged the idea that regulation is designed and operated primarily for the benefit of companies, rather than solely to advance the overall public interest by correcting market failures. Since the 1970s, with the introduction of the economic theory of regulation and the rise of EMA, regulatory activity has developed into a global field of practice and research, expanding particularly in the 1980s and 1990s. From a global perspective, regulatory bodies have been formed; the language of regulation has become widespread in public and academic discourse. The efficiency of numerous approaches and tools of regulation have been reviewed, specifically in the context of monetary crises, environmental disasters, and the safety of food and medicine (Majone, 1996:11).

The GRI (2013) developed the GRI Sustainability Reporting Standards to assist companies and governments globally to understand their impact regarding climate change, human rights, governance, and social well-being. Public and other stakeholders can see how companies take the correct actions regarding social, environmental, and economic benefits for everyone.

The Institute of Directors (IOD) (2016) brought about the King reports culminating in King IV of which the goal can be described as transparency in sound corporate governance. With corporate governance companies can look after the environment, health and public safety, and focus on the impact of the company's activities and of its products and services.

However, Gray (2015:1) maintains that environmental legislation raises production costs at regulated companies although in most instances, costs are only a minor portion of companies' total costs. Productivity tends to fall hence companies might relocate their investment and production to locations with less stringent regulation. On the other hand, environmental guidelines have had huge benefits regarding saving

lives as well as preventing illnesses, especially through minimising the level of airborne pollution. The prospective health benefits might be higher in developing countries where pollution levels are high. The benefits to society from an environmental perspective seem to be much greater than the costs of compliance.

The researcher opines that companies should factor environmental costs into their annual budgets; redefine their processes to identify wasteful activities, and benchmark on an annual basis to determine their savings.

2.18.1 Carbon tax

Globally, it has been noted that the demand for energy globally and in South Africa has led to high carbon emissions. Unfortunately, this affects the environment and people. Different policies and legislations have been implemented to address or force companies to reduce their carbon emissions (Friedman, Klein & Sun, 2012:19). The objective of carbon tax is to change the behaviour of companies by providing incentives and to move towards cleaner technology when replacing/renewing machinery and processes. The carbon tax brings the price of carbon closer to its true social cost. This Pigouvian approach is widely regarded by economists as a legitimate way to address the externality problem. To ensure that South Africa transitions to a low-carbon, climate-resilient economy in a cost-effective and economically efficient manner, it is important that the trade-offs between inclusive economic growth, poverty alleviation, job creation, and the lowering of GHG emissions are effectively managed (Li & Zhao, 2017:9).

South Africa's National Treasury released its Carbon Tax Policy Paper in May 2013, which suggested that carbon tax should be charged based on the total summation of the GHG emissions of a taxpayer with regard to a tax period articulated as the CO_2 equal of GHG releases (National Treasury, South Africa, 2017:9). The paper proposed a R120/tCO_2-equivalent levy on coal, gas and petroleum fuels. A proposed model demonstrated that the carbon tax has the capacity to decrease South Africa's greenhouse gas emissions (GHGs) by between 1,900Mt CO_2-equivalent and 2,300Mt CO_2-equivalents between 2016 and 2035. Therefore, accounting systems should be implemented within companies to permit the detection of physical and financial implications of environmental impacts. These accounting systems will be critical for quantifying and calculating environmental impacts such as carbon tax/CO_2 or volatile

organic compounds (VOC) discharge tax (van Heerden, Blignaut, Bohlmann, Cartwright, Diederichs & Mander, 2016:714; Iyer-Raniga, 2019:10).

The South African carbon tax was implemented on the 1st June 2019. It adheres to the polluter-pays principle (PPP) and prices GHGs. Moreover, it seeks to ensure that companies and households take these costs into consideration in their production, consumption, and investment decisions. It is envisaged that the tax will assist in reducing emissions and ensuring South Africa meets its commitments under the 2015 Paris Climate Agreement (United Nations Climate Change, 2018:1). It will be reviewed after three (3) years. SARS and the Department of Environmental Affairs (DEA) will jointly administer the tax. To ensure a smooth administration, SARS published the draft rules for consultation in March 2019 (National Treasury, South Africa, 2019:1).

From the above and the earlier discussion on stakeholder aspects, we deduce:

- PROPOSITION *PA5*: There is a flow of regulatory information between the regulatory environment and the stakeholder environment.

The regulatory aspects addressed also lead to a number of *content* propositions:

- PROPOSITION *PC12* – Coal mining companies ought to adhere to government legislation. Coupled with such legislation should be adherence to GRI guidelines, and King IV principles.
- PROPOSITION *PC13* – Coal mining companies ought to adhere to government Carbon tax regulations.

2.18.2 Environmental taxes in South Africa

The South African Cabinet approved the Carbon Tax Bill in August 2017. Legislature summoned enquiries after the publication of the draft bill in December 2017 and was passed in 2018. Government suggests enforcing the levy from 1 January 2019 to achieve its nationwide targets. To decrease solid waste and discourage clients from purchasing plastic bags, the plastic bag tariff increased by 50 per cent to 12 cents per bag, with effect from 1 April 2018. The carbon tax on luminous light bulbs will be increased from R6 to R8 to encourage consumers to use an energy-proficient conduct. This initiative took effect from 1 April 2018. The automobile discharges levy was raised

to R110 for each gram exceeding 120 gCO_2/km for commuter cars and R150 for each gram exceeding 175 gCO_2/km for dual cab automobiles with effect from 1 April 2018 (van Walbeek, 2014:3; The National Treasury, South Africa, 2018:47).

2.18.3 Environmental health regulation in South Africa

The transition to democracy in South Africa led to increased development of legislation and policies aimed at protecting the environment. The South African constitution provides the right to a safe and healthy environment. New legislation has been enacted to preserve or improve environmental quality such as the National Environmental Management and Air Quality Act, 39 of 2004 (DEA, 2018:1). The country is signatory to a wide range of global agreements and protocols. For example, the Montreal Protocol which relates to ozone depletion (Environmental and Energy Study Institute, 2009:1) and the Basel Convention which deals with control of trans-boundary movements of hazardous waste (United Nations Environmental Programme, 2019). Government banned the use of asbestos within households, eliminated leaded petrol, and controlled the use of lead in paint. Moreover, environmental impact assessments (EIAs) are now a prerequisite for large industrial developments (Mathee, 2011:38).

South Africa is signatory to the values of sustainable development throughout its governance framework; principally through sustainable development being enshrined in Section 24 of the South African Constitution:

> *"24. Environment – everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that (i) prevent pollution and environmental degradation; (ii) promote conservation; and (iii) secure environmental sustainable development and use of natural resources while promoting justifiable economic and social development" (South African Government Gazette, 1996).*

Consequently, South Africa is committed, as demonstrated in the Mineral and Petroleum Resources Development Act (MPRDA) and the National Environmental Management Act of 1998 (NEMA) (DEA, 2013:1) amongst others, to addressing mine closure and its related environmental implications in a way that would promote

sustainable development (Department of Water and Sanitation (DWAS), 2013:1; Department of Environmental Affairs and Tourism (DEAT), 1998).

South Africa is a mineral-rich country with a long established and economically important mining sector. It may be one of the best locations to test if sustainable mine closure, and, therefore, sustainable development is achievable in the mining context. Historically, mine closure has been environmentally inept leaving lasting negative consequences. This is exacerbated by the fact that South Africa has more than 5,000 ownerless and derelict mines. As these mines revert to this state when abandoned, it is estimated that the environmental liability facing the state is at least R30 billion for environmental restoration. This excludes mines that are not functioning but are under different levels of care and conservation. That is, they do not have final legal closure yet (McCarthy, 2011:2).

Overall, derelict mines continue to generate environmental effluents such as AMD, the associated mobilisation of heavy metals, decreased soil fertility, surface instability and airborne PM_{10} dust amongst others. PM_{10} is particulate matter 10 micrometres or less in diameter; $PM_{2.5}$ is particulate matter 2.5 micrometres or less in diameter. In comparison, a human hair is about 100 micrometres, so roughly 40 fine particles might be placed on its width. Closed mines tend to obviate useful future land use to the detriment of environmental functioning and human health. What makes matters worse is that in practice, mine closure is often poorly planned thereby creating environmental hazards (Loate, Padia & Maroun, 2015:29). Moreover, the burning of coal in households is a significant source of low-level fine particulate PM_{10} and $PM_{2.5}$ and contributes significantly to $SO_{2,}$ CO_2 total organic compounds and benzene emissions (DEA, 2011:29).

Note how the above recommendations support content PROPOSITION *PC4* on health regulations.

2.18.4 EMA as a monetary internal environmental accounting tool

It has been admitted that companies are compelled to change due to increased environmental legislations and growing environmental awareness from stakeholders such as consumers and shareholders. However, different methodologies to accounting are required to address different issues of concern to relevant shareholders. While some accounting systems can provide common information for

all stakeholders, accounting systems may be structured to provide specific information for use by, or to communicate with different stakeholders (Schaltegger *et al*. 2000:18; Division of Sustainable Development (DSD), 2001:1).

Conventional management accounting is argued to neglect separate identification, classification, measurement and reporting of environmental information, especially environmental costs. Therefore, most companies do not integrate their environmental costs into business decision-making. Accordingly, it can be argued that MA is unable to capture environmental costs as beneficial information for decision-making purposes. Conventional management accounting is the central tool and basis for most internal management decisions and is not widely available to external stakeholders since such information is economically sensitive and confidential. Management accounting considers issues of identifying the type of environmental costs and how these environmental costs should be traced and treated. For instance, determining whether environmental costs should be assigned to products or counted as overhead costs (Schaltegger *et al*. 2000:18; Burritt, 2004:14; Bhimani, 2020:9).

From a material point of view, the focus of environmental accounting is very different from that of conventional accounting. The focus of environmental accounting is on environmental impacts whilst the focus of conventional accounting is on financial impacts. Environmental and financial information is often derived from different sources. This information is often required more for various purposes and by different stakeholders than monetary information. Environmental information has different measures of quality and quantity, such as kgs, from financial information. However, sustainability accounting describes a subset of accounting that deals with activities, methods and systems of analysis (Schaltegger *et al*. 2000:14). Moreover, to report issues such as environmentally and socially-induced financial impacts, the interactions and linkages between social as well as environmental and economic matters constituting these dimensions of sustainability should be determined (Schaltegger & Burritt, 2009:376).

In view of the preceding arguments, companies may need to be able to record, manage and report the level of sustainability for their business activities, as well as indicate mitigation to determine whether there is any deviation from sustainability measures.

An *association* proposition emanates from the above discussions:

- PROPOSITION *PA6*: The said tools or methodologies can provide stakeholders with information to make informed decisions.

Note also how the foregoing supports association PROPOSITION *PA5* identified earlier.

2.18.5 EMA as a general term for internal environmental accounting

However, it has been argued that EMA justifies the link between environmental impacts and financial statements about the bottom line. No clear link is provided as to how environmental management teams and accounting teams within companies can function together with the sharing of information. However, information on environmental costs provided by the accountants can function as a starting point for environmental managers to shape the environmental measurement systems, as well as to provide a foundation for environmental reporting and recommend options to improve material efficiency (Schaltegger & Figge, 2000:30). In the same context, accountants may utilise the information provided by the environmental managers to assist in their financial analysis in instances where they are faced with decision-making challenges. Cost (or management) accounting constitutes the central tool for internal management decisions such as product pricing and is not regulated by law. Therefore, EMA represents a combined approach, which provides for the transition of data from financial accounting, cost accounting, and material flow balances. This will increase material efficiency, reduce environmental impact and risk, and reduce costs of environmental protection (Jasch, 2003:667; Jasch & Lavicka, 2006:1216).

EMA characteristically includes life-cycle assessment, total calculation of costs, valuation of profits, and strategic forecasting for environmental management. Based on this explanation, it may be argued that IFAC (2005:19) makes no systematic difference between financial and non-financial characteristics of EMA. Environmental financial accounting (EFA) comprises environmental focused financial aspects including physically measured environmental effects for reporting to external shareholders. This subsequent classification of accounting systems must cover the accounting systems with particular external investors, regardless of whether they are interested in financial or environmental information (Schaltegger *et al*. 2000:6).

The preceding section established that legislation on its own is not enough in terms of environmental compliance. However, companies should take responsibility in ensuring that their operations are environmentally friendly.

The above leads to an *association* as follow:

- PROPOSITION *PA7*: There is a direct link between the regulatory environment and the purpose in terms of reducing pollution and improving costing.

Note how the above relationship proposition reinforces content propositions, namely PROPOSITION *PC2* (water pollution) and PROPOSITION *PC11* (LCC costing).

The next section discusses the environmental strategy.

2.19. ENVIRONMENTAL STRATEGY

The view by Gunarathne and Lee (2015:8) indicates that corporate social environmental responsibility has been the focus of global and media attention in recent years. This is due to concerns regarding environmental hazards such as climate change, GHGs and environmental degradation. Therefore, a company's performance is no longer measured in terms of financial performance, but rather by their environmental impacts. One consequence of this trend has been a strong desire among stakeholders to encourage managers to focus more on environmental issues and environmental performance evaluation (Rodrigue, Magnan & Boulianne, 2013:301). To realise this goal, many companies have considered implementing a sustainable environmental strategy and using EMA to improve their environmental performance. However, it is unclear whether a combination of these two (2) practices can improve the environmental performance of a company as a whole, given that the reporting of environmental performance in some countries remains voluntary, with a low level of disclosure, particularly in developing countries (Wagner & Schaltegger, 2004:558; Burritt & Schaltegger, 2010:829).

The NRBV concept suggests that competitive advantage can be maintained whenever the abilities of creating the advantages are supported by resources that are not easily duplicated by competitors. NRBV and its three (3) interrelated strategies provide an easy way to understand the environmental challenges faced by companies, particularly relating to companies' environmental strategies. Researchers such as

Dowell, Hart and Yeung (2000:1062) demonstrated evidence through the lens of the theoretical NRBV and established that an effective environmental strategy could be valuable, rare, and difficult to imitate if resources or capabilities that are not replaceable can generate a sustainable competitive advantage.

Hart and Dowell (2011:1465) observed that if the development in environmental performance is focussed on promoting a company's reputation, this will enhance the company's ability to manage its resources. An improved image implies that the amalgamation of resources and capabilities across all the various parts of the company will be more profitable. Company-specific competences could be cost reduction, improved operations, better product quality, product differentiation strategies, improved employee work ethic, as well as improved company reputational image. The NRBV would direct corporate environmental strategy in line with the use of EMA thereby positively impacting environmental performance.

2.18.1 Environmental strategy and environmental performance

A company with an environmental strategy that is focussed on environmental shareholder value (ESV) accomplishes better environmental performance than a company that lacks such orientation. A company's willingness to reveal its environmental performance exhibits commitment to its environmental strategy. It has been noted that companies strive to make a voluntary disclosures to comply with environmental standards (Wagner & Schaltegger, 2004:558). The attention given by management to environmental issues will affect the company's ability to establish a proactive environmental strategy. An orientation toward proactive strategies that lead to improvement in a company's environmental performance must move beyond mere compliance with existing regulations. Good environmental performance may be as a result of a good corporate environmental strategy. A company should continue to document and develop environmental performance indicators to address existing environmental issues (Rodrigue *et al.*, 2013:301).

Most companies focus on environmental strategies such as environmental performance, pollution prevention, product development, and CSR, and these are challenging matters (Hart & Dowell, 2011:1464). Companies' strategic initiatives for a sustainable environment are sometimes not enough to allow them to develop a

strategy that can address social and environmental challenges. How companies' implement environmental strategies will be evident in its environmental performance, and moreover, their environmental performance assessment will signify the importance of a proactive corporate environmental strategy (Clemens & Bakstran, 2010:394).

An improvement in companies' environmental strategies supports the use of indicators to ensure environmental performance in the long-term. Companies can improve their environmental performance based on stakeholder decisions. On the other hand, shareholders can manage the company's environmental performance. The stakeholders and companies can work together to achieve the mutual goal of realising the companies' goals through its environmental strategy (Lisi, 2015:27). Research by Journeault (2016:150) demonstrated that a company's strategic planning environment can improve environmental performance as part of the EMA package within its environmental capabilities, which will ultimately also improve economic performance.

It the previous section, it was indicated that a good environmental strategy can ensure efficient environmental performance. However, the adoption and successful implementation of EMA will be dependent on the knowledge and skills of each company.

The above leads to:

- PROPOSITION *PC14*: An environmental strategy is vital for a coal mining company.
- PROPOSITION *PC15*: Decision-making is vital for a coal mining company.

From the above it is inferred:

- PROPOSITION *PC16*: A good performance based on the above strategy and decision-making is vital to facilitate coal mining environmental success.

The following section explores the uses and benefits of EMA.

2.19 USES AND BENEFITS OF EMA

Although IFAC (2005:19) identified the limitation and weakness of EMA, EMA may not merely be one environmental management tool among many. Rather, EMA is a broad set of principles and approaches that provide the data essential to the success of many other environmental management activities.

Figure 2.17 depicts the uses and benefits of EMA.

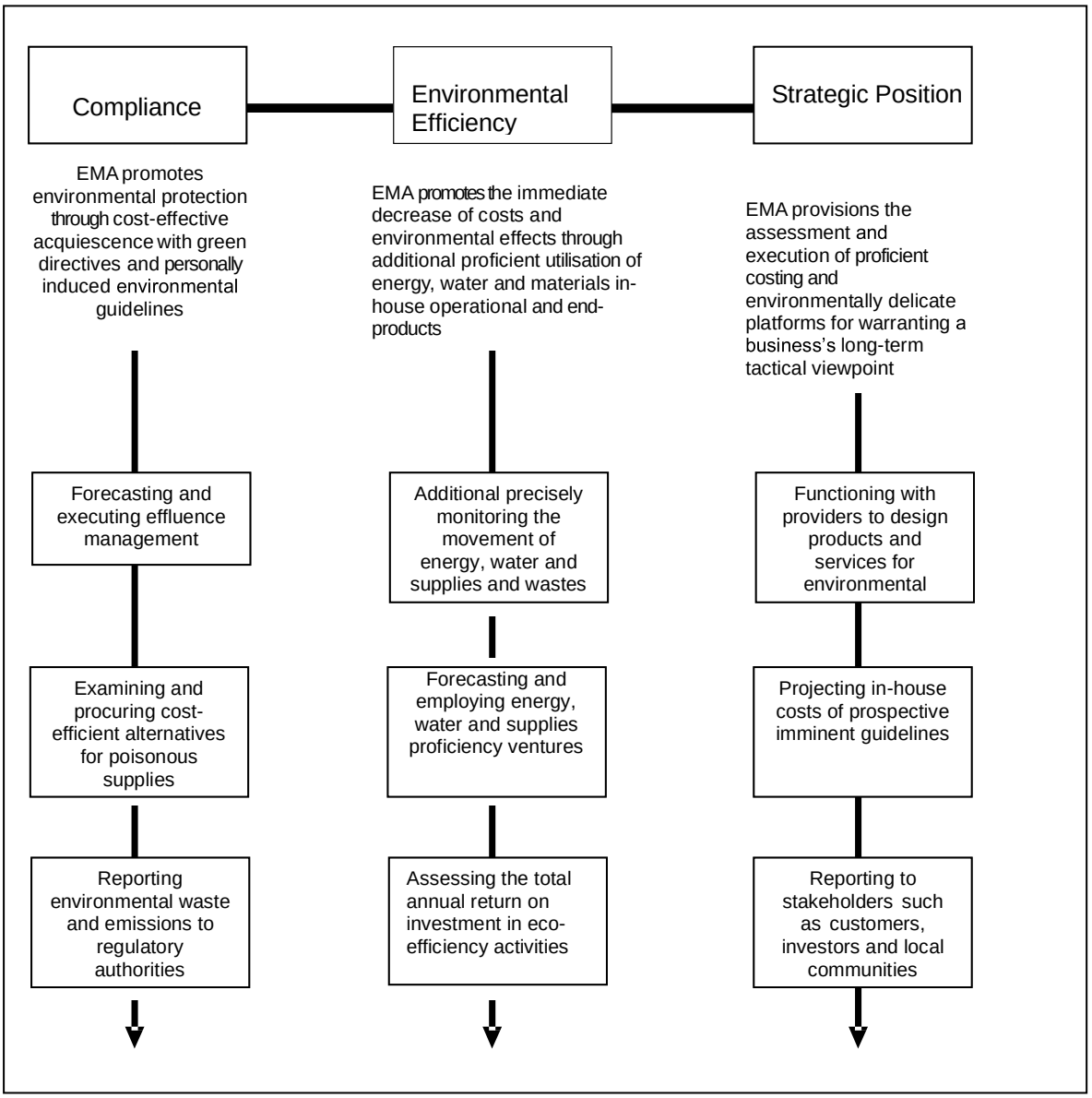

Figure 2.17: Uses and benefits of EMA

Adapted: *Federal Environmental Ministry (2003:7)*

It could be highlighted (Figure 2.17) that the uses and benefits of EMA are classified into three (3) sections. These include compliance, eco-efficiency, and strategic

position. Compliance advocates EMA to promote environmental protection through cost-effective acquiescence with green directives and personally induced environmental guidelines. EMA environmental efficiency promotes the immediate decrease of environmental costs and environmental effects. This could be achieved through additional proficient utilisation of energy, water, and material internal operations and end products (Federal Environmental Ministry, 2003:7). The strategic position of EMA provides the assessment and execution of proficient costing and environmentally delicate platforms for providing a business' long-term tactical view (Federal Environmental Ministry, 2003; UN, 2001). Emerging economies are faced with the challenge of striking a balance between developmental goals and preserving the environment. To adapt to the changes, companies should develop dynamic capabilities for environmental innovation and corporate sustainability (Zhang, Sun, Yang & Li, 2018:13).

The researcher opines that the assertion by IFAC (2005:19) is that there are no clear processes or guidelines as to what companies should do to achieve these benefits of EMA. However, companies may only achieve these benefits if EMA is adopted and implemented at a corporate level. This should be included in company policies and procedures for practical application.

In this section, it was demonstrated that the uses and benefits of EMA can be categorised into compliance, environmental efficiency, and strategic position. Therefore, companies need to understand the type of benefits that they can achieve if they adopt and implement EMA.

The following section discusses EMA as a tool to support management decisions.

2.20 DECISION-MAKING: EMA AS A TOOL TO SUPPORT MANAGEMENT DECISIONS

It has been argued that companies that have implemented EMA are able to achieve positive results on their environmental and economic performance. However, EMA should be customised to the specific needs of each company instead of being generalised to all companies. As a result, the impact of EMA is strengthened when companies use EMA as a tool for aiding decision-making in integrating EMA at all levels of operations and not just utilising it for a short period (Klassen & McLaughlin, 1996:1202). A survey raised questions of whether environmental issues are being

addressed at a corporate level and whether environment-related management accounting should be regulated or at the very least promoted by way of providing incentives to ensure environmental compliance for internal management decision-making (Schaltegger, & Wagner, 2005:2).

It could be highlighted that environmental strategies imply the company-wide recognition of the legitimacy and importance of the biophysical environment in the formulation of company strategy (Banerjee, 2002:181). According to Garzella and Fiorentino (2014:68), this definition leads to three (3) critical characterisations:

- Environmental strategy is a complicated phenomenon that refers to a multi-criteria approach to green management decision-making.
- Environmental issues concern the overall strategic process in both the formulation and implementation stages.
- However, the adoption of environmental management policies does not automatically provide environmentally-positive results.

The researcher postulates that these characterisations should be part of the companies' strategy and policy, driven from an executive level to all operational levels to ensure consistency of implementation. This could be attained by integrating these into the KPAs or KPIs of employees at all levels.

Figure 2.18 portrays a framework for green management decisions.

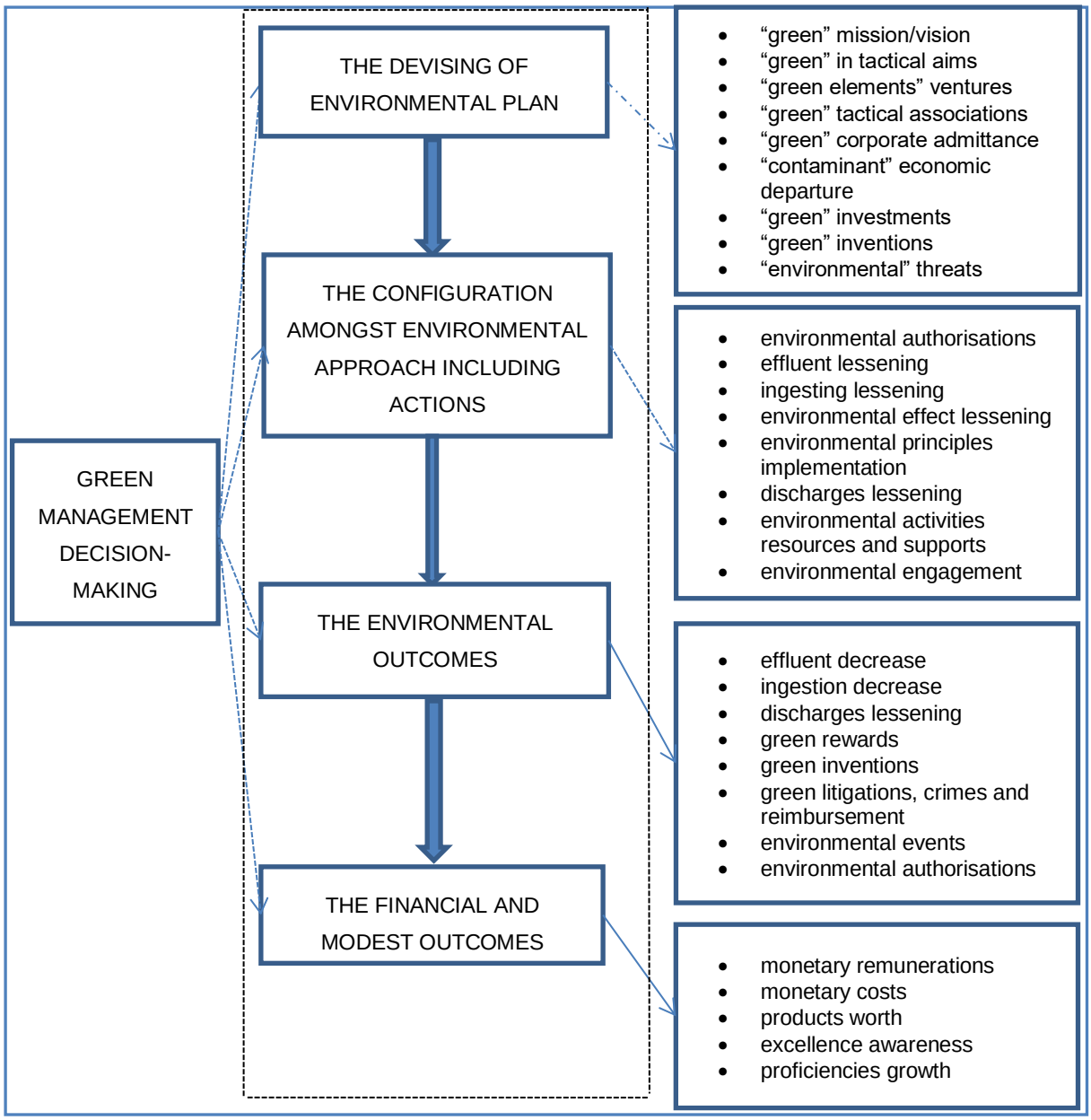

Figure 2.18: A Framework for green management decisions

Source: *Garzella and Fiorentino (2014:82)*

Figure 2.18 demonstrates the framework for green management decisions that should be defined in line with the formulation of an environmental strategy, alignment between environmental strategies, the environmental and financial results. The framework links hypothetical and operative suggestions and tends to examine environmental approaches in an efficient method. The framework (Figure 2.18) consists of four (4) phases on green approaches that are intended for assimilating environmental management guidelines into the tactical procedure. There are 30 objects which define the core EMA activities. The framework might be figured as a process plan which

serves as a foundation that should be used by company executives in implementing environmental management. For instance, executives and management have a duty to assess every respective possibility for environmental actions based on the four (4) enquiries such as why, where, how, and what by marking relevant and matching boxes on the diagram (Garzella & Fiorentino, 2014:68).

The foregoing section established that an environmental strategy could be used as a tool to support management decisions for the companies.

Note how the above discussion reinforces PROPOSITION *pA5*, namely an association between tools (methodologies) and purpose.

The following section investigates aspects of costing.

2.21 IMPROVED COSTING

A lack of guidance on EMA causes difficulties in effectively collecting, identifying, analysing, and assessing environmental data. Environmental costs, revenues, assets and liabilities need to be correctly assessed and allocated to mitigate the risk of sub-optimisation. There should be a match between the conventional, existing cost accounting systems and items; and ECA guideline items. This will be able to address a gap between operations and government guidelines, since the current conventional costs accounting system have little or no cost items or categories that reflect environmental cost information (Lee, 2010:44; Setthasakko, 2010:326).

Therefore, if the improvement in environmental performance is directed towards a company’s reputation, it will indirectly increase the company's ability to manage its resources. An improved reputation means that the combination of resources and capabilities across all different parts of the company will be more profitable. The company-specific capabilities could be cost reduction, improved operations, better product quality, product differentiation, improved employee morale, and improved company reputation (Sharma & Vredenburg, 1998:729).

This section highlighted the need to have a link between the conventional existing cost accounting systems and EMA. Companies should have proper systems in place that will identify wasteful activities and budgets allocated to mitigate environmental damage.

The above leads to a *general* future-work proposition:

- PROPOSITION *PG3*: A link between conventional, existing cost accounting systems and EMA is needed.

And a content proposition:

- PROPOSITION *PC17*: Coal mining companies ought to calculate correctly, and attempt to improve on the cost of their operations (improved costing), hence they ought to pay close attention to their profit margin.

From earlier propositions, that is PROPOSITION *PC8* (waste reduction) and the above costing and profit-margin one (*PC17*), we could infer:

- PROPOSITION *PC18*: The Information system should provide information relating to savings on raw materials, profit margin (PROPOSITION *PC17*) and decision-making (PROPOSITION *PC15*).

A further aspect that emerged throughout the discussions in this chapter is an omnipresent risk factor, hence:

- PROPOSITION *PC19*: A coal mining company ought to keep a close eye on its risk profile.

Through a synthesis of the above propositions – *general*, *content-driven*, and *association* – we arrive at our preliminary decision-making framework in Figure 2.19, aimed at facilitating cost savings and the mitigation of environmental impacts in the coal mining industry.

2.22 DISCUSSION OF THE PRELIMINARY FRAMEWORK

The preliminary framework presented in Figure 2.19 demonstrates six (6) key propositions such as purpose, environment (stakeholders), subject field, tools (methodologies), regulatory aspects as well as the identification of risk. These propositions are linked based on their association as depicted by the legend.

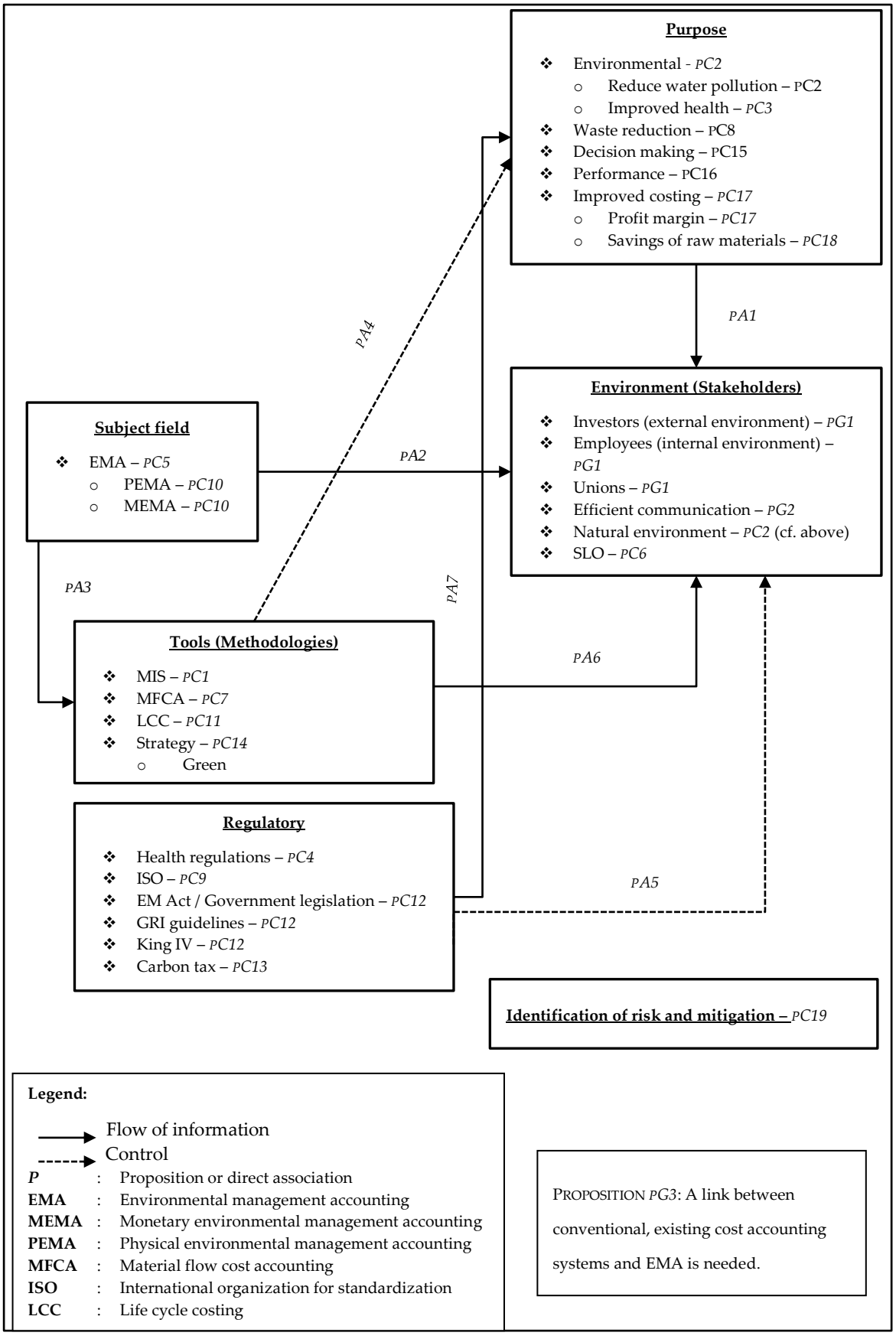

Figure 2.19: A decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry (Researcher's own)

In summary, the preliminary framework serves as a tool and guideline for providing the coal mining companies with information relating to costing and savings. The unbroken arrows indicate the flow of information whilst the dashed arrows indicate control. The savings and costing information is influenced by components such as ISO, MFCA, LCC, and green strategy. In the same context, PEMA provides savings information and MEMA provides costing information to companies and their stakeholders. These stakeholders include investors and the natural environment (external environment); and the employees (internal environment).

There is a need for companies to comply with the regulatory requirements such as GRI guidelines, ISO requirements, King IV, and other South African legislations such as the EMA processes. Stakeholders need to be informed regarding the regulatory requirements to make informed decisions. The preliminary framework has been refined based on the input gathered from the personal interviews and validated through a focus group. Therefore, the enhanced framework is presented at the end of Chapter 5, addressing the main objective of this study which was to develop a decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry.

2.23 SUMMARY

This chapter provided the theoretical lens and reviewed existing literature. A deliberation on stakeholder theories established that companies should strive to address social expectations to gain social acceptance (corporate social responsibility.) By doing so, the companies will be able to achieve corporate sustainability. It was established that there are two (2) branches of EMA, namely physical EMA (PEMA) and monetary EMA (MEMA). PEMA involves the movement of water and energy whilst MEMA measures the costs of the business's utilisation of natural assets and the costs for mitigating environmental degradation (p1). Reviewed literature indicated that although mining is unique in nature, mining activities create environmental impacts such human diseases and environmental pollution. A comparison between the Centralia mine in the USA and the Blesboklaagte mine in South Africa established similarities in terms of environmental impacts. This chapter also established that companies do not have enough information at their disposal to forecast and predict future environmental impacts. This means that they would be faced with future

uncertainties hence they might also incur hidden environmental costs. Therefore, companies need to understand their environmental costs and be able to benchmark on possible savings based on the implementation of EMA.

However, LCC and MFCA could be used as effective EMA tools to identify waste within companies to determine investment opportunities (p4). Therefore, companies should take responsibility in ensuring that their operations are environmentally friendly. A good environmental strategy should ensure efficient environmental performance in any industry. Therefore, this provides a link between strategy and EMA. The uses and benefits of EMA could be categorised into compliance, environmental efficiency, and strategic position. Compliance advocates EMA to promote environmental protection through cost-effective acquiescence with green directives and personally-induced environmental guidelines. EMA's environmental efficiency promotes the immediate decrease of environmental costs and environmental effects through additional proficient utilisation of energy, water, and materials internal operational and end products. On the other hand, strategic position of EMA provides the assessment and execution of proficient costing and environmentally-sensitive platforms for warranting a business's long-term tactical view.

Lastly, this chapter established the need to have a link between the conventional, current cost accounting systems and EMA. Companies should have proper systems in place that will determine wasteful activities and budget allocated to mitigate environmental degradation. A framework for facilitating cost savings and mitigating environmental impacts in the coal mining industry (Figure 2.19) was developed on the strength of the literature discussed in this chapter.

The upcoming chapter unpacks the research methodology that was utilised in addressing the research objectives of this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. INTRODUCTION

In the previous chapter, existing literature was reviewed limited to the research problem, the purpose and objectives of the study, hence this process informed the research instruments. The researcher personally engaged the coal mining sector to acquire primary data from the participants. To eliminate bias, three (3) qualitative research techniques of data collection, namely an extensive literature review, personal interviews and a focus group to validate the developed framework were used. The personal interviews and focus group enabled the researcher to consolidate the findings of the study and to enhance the framework that is presented at the end of Chapter 5.

3.1.1. Goal of Chapter 3

The goal of this chapter is to demonstrate the research methodology that was utilised to address the objectives of this study.

3.1.2. Layout of Chapter 3

The layout of the chapter is as follows: In Section 3.2 the triangulation of research techniques is illustrated followed by the research design in Section 3.3. In Section 3.4, the internal trustworthiness is portrayed. In Section 3.5, ethical considerations are discussed followed by linking research objectives and research methodology in Section 3.6, the relevance of the study in Section 3.7 and concludes with a summary in Section 3.8.

3.2. THE TRIANGULATION OF RESEARCH TECHNIQUES

The researcher assumed that the environmental effects of coal mining on the environment are a contentious topic which should be treated with caution. To avoid bias, the researcher utilised triangulation, namely personal interviews and a focus group as theoretical validation of the framework.

Figure 3.1 depicts the triangulation approach (research techniques) that was utilised in this study.

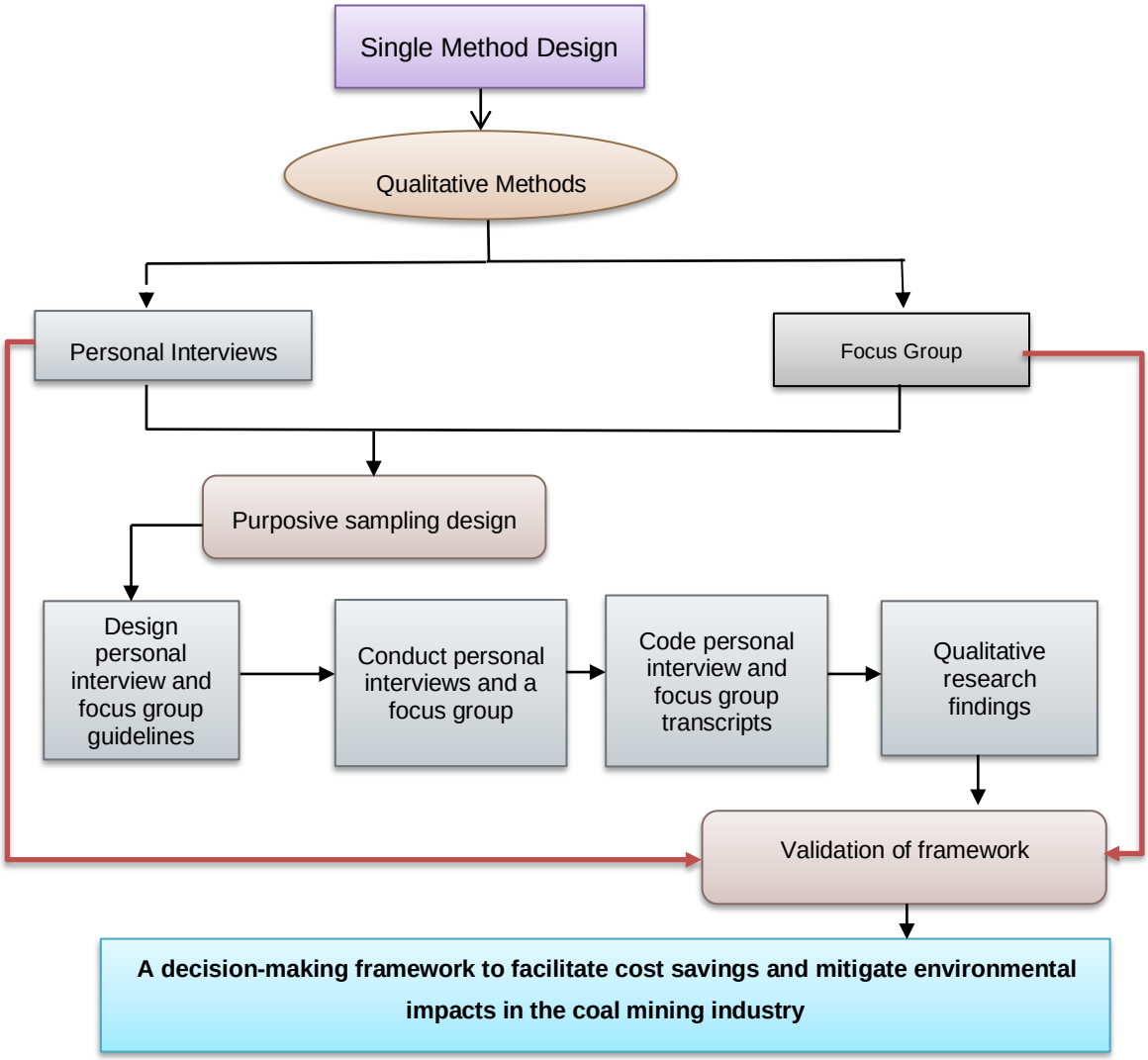

Figure 3.1: The research process

Source: *Researcher's own construct*

The triangulation approach minimised bias in the sense that each of the three (3) techniques has its own distinct advantages. A preliminary framework was developed through a survey of scholarly literature. The research instrument for personal interviews was developed from an extensive review of literature whilst the focus group was utilised to validate the framework. Personal interviews assisted the researcher to create rapport with the participants. In validating the framework, the researcher approached Coaltech, a research body that manages a group of companies in South Africa. Permission was granted hence the researcher successfully presented to seven (7) coal mining companies who were part of the focus group session. As per the focus group guidelines and ethical considerations, the session was voice recorded with the consent of the participants, hence 12 participants were part of the focus group. The

input from the focus group session enabled the researcher to enhance the preliminary framework and determine its relevance and applicability. The focus group session provided an environment which allowed participants to disagree with each other's views. Even though it is argued that a focus group is usually characterised by a non-directive style of interviewing, the main objective was to promote extensive views on the discussions in the focus group. The objective was not to reach an agreement regarding the issues or to provide solutions, but to elicit different arguments relating to the topic. If the correct participants were not recruited for the focus group sessions, it means that the purpose of a focus group could have been compromised (Brinkmann & Kvale, 2009:150; Greenbaum, 2000:49).

3.3. RESEARCH DESIGN

A research design implies a structure for collecting and analysing data. It is like an architectural blueprint that is followed in the construction of a building. For instance, specifying what material is required, how much will need to be sourced and the layout of the building (Wagner *et al*., 2012:21). The research design of the study followed the research onion portrayed in Figure 3.2.

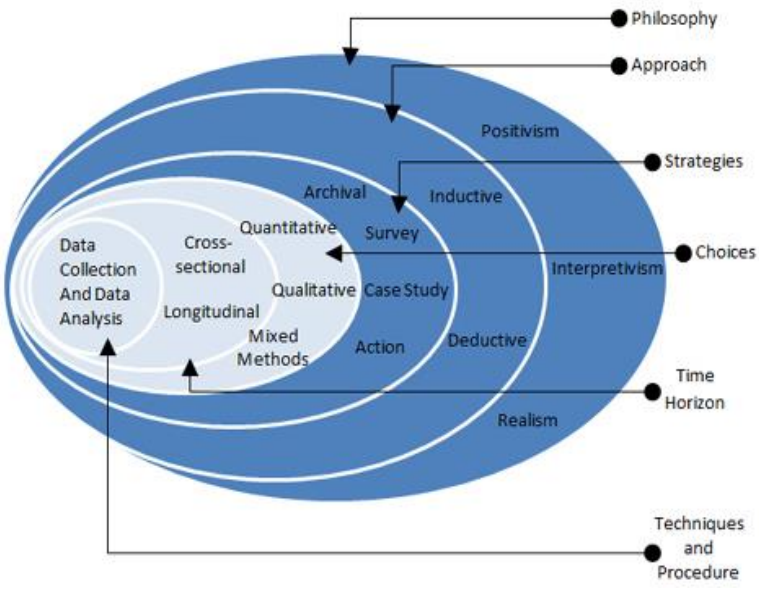

Figure 3.1: The research onion

Source: *Saunders et al. (2016:164)*

3.3.1. Research philosophy

The outermost layer is the theory that has two (2) major sets: ontology and epistemology. In the case of this study, ontology is a systematic philosophy, in this case evaluating the development of the decision-making framework to facilitate and mitigate cost savings of environmental impacts in the coal mining industry. Hence, an ontological philosophy was employed in this study (Saunders *et al.*, 2016:164; Wagner *et al*., 2012:54).

Interpretivism was used as part of ontologies. Two (2) instruments were developed: one for the personal interviews and one for a focus group. A focus group session was conducted to validate the preliminary framework as a way of sourcing unbiased views from the coal mining industry. The process of validating the framework facilitated the enhancement of the framework based on received feedback.

3.3.2. Research approach

The review of scholarly literature was used to develop a conceptual framework. A primary inductive approach was used through a comprehensive literature review as well as personal interviews (Mbedzi *et al.*, 2018) and a secondary deductive approach to validate the framework through a focus group.

3.3.3. Research strategies

Surveys, in the form of face-to-face interviews and a focus group, were employed as research strategies. The researcher took notes and used a digital recorder with the permission of the participants during the face-to-face interviews and the focus group. Face-to-face consultations may produce an abundant set of expedient information. However, the people's experience is seldom as precise as the recording devices would be (Leedy & Ormrod, 2015:160). On the other hand, a focus group is particularly convenient in instances where there is constraint of the time framework; participants participate with greater ease in group sessions than as individuals and communication amongst participants might be more enlightening compared to individual sessions (Leedy & Ormrod, 2015:282).

There were no objections as all respondents who participated in the personal interviews and focus group consented, therefore, indicating their willingness to

participate in the study. Different questions were asked for the face-to-face interviews and focus group to assess responses from both. This means that there were two (2) research instruments, one (1) for the personal interviews and the other for the focus group (Annexures A and B).

3.3.4. Research choice

A qualitative research choice was chosen for this study.

3.3.5. Research techniques and procedures

In the following sub-sections, the study area, purposive sampling, data analysis and techniques, and the process of organising and analysing data are discussed.

3.3.5.1. Selection of the study area

This study focussed on the South African coal mining industry. Most of the coal deposits in South Africa are in the South African Highveld, Emalahleni, the Ermelo area, and Lephalale in Limpopo. Therefore, the participants were selected from the stated areas for the purposes of this research. The researcher postulates that this offered trustworthiness and credibility to the study since the correct sector was targeted.

3.3.5.2. Purposive sampling

Although there are 46 companies profiled including 19 testing facilities. Profiled companies include major coal miners such as South32, Glencore, Sasol and Exxaro Resources, and many smaller producers such as Kuyasa Mining and Londani Coal (PR Newswire, 2020:1). However, purposive sampling was used to select 50% of all coal mining companies in South Africa. All coal mining companies in South Africa formed part of the population; hence, they all stood a chance of being sampled. In purposive sampling, the researcher chooses the specific companies to be included in the research (Leedy & Ormrod, 2015:179).

- **Composition of the sample**

The sample was composed of all levels of employees within the coal mines in South Africa. These ranged from Supervisors, Senior Managers, General Managers, Chief Executive Officers (CEOs) and employees from different coal mining companies.

3.3.5.3. Data analysis and techniques

The researcher used in vivo coding to analyse the data collected from personal interviews and the focus group. A code in qualitative research is defined as a term or short expression, which literally allocates a comprehensive, significant and/or suggestive characteristic for a particular language-based or virtual data. In vivo, coding is arguably the most recognised and utilised qualitative coding technique. It utilises phrases or short expressions from the participant's personal dialectal facts as a code. It may include traditional or indigenous terms of a certain cultural, subcultural, or micro cultural being of the cluster's social groups (for example code blue, sharps, and scripts.) The researcher classified the data into categories based on similarities. Similar categories of data were analysed to gain an understanding of the different views gathered from the personal interviews and focus group.

3.3.5.4. The process for organising and analysing data

To organise and analyse the data that was gathered through the personal interviews and focus group, the researcher applied the data analysis spiral process as demonstrated by Creswell (2012:179).

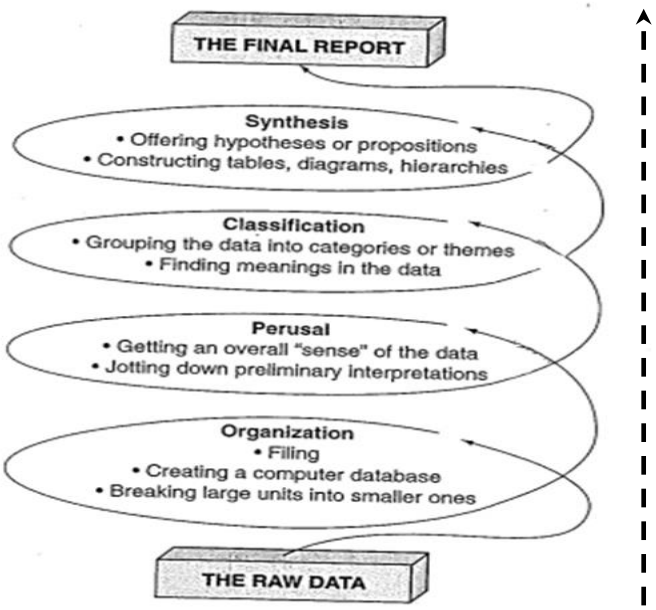

Figure 3.2:The data analysis spiral process

Adapted: *Creswell (2012:179)*

3.3.5.5. What the researcher did in organising and analysing data

Borrowing from Creswell (2012:179) as portrayed in Figure 3.4, the researcher firstly organised the unprocessed data by synthesising substantial components of the records into minor elements, generating a folder, and making personal notes. This is a bottom-up spiral procedure as indicated by the dashed line with an arrowhead on the right of Figure 3.4.

Secondly, the researcher perused the data several times to gain an understanding of the underlying semantics or what it really contains. The researcher categorised the data into smaller relevant units and at the same time tried to get an overall sense of the data. The researcher reviewed the digital recordings in case there was a missing link and to get clarity.

Thirdly, the research classified the data by identifying key themes that emerged during the personal interviews. Moreover, the researcher used a table as saturation point indicating where new themes were no longer emerging.

Fourthly, the researcher synthesised the data by integrating and summarising the data for those who might read the report. This stage included providing suggestions that define relations among the groupings.

Leedy and Ormrod (2015:317) suggest that irrespective of how the researcher proceeds, the researcher should understand that the data analysis for a qualitative study is a complex and time-consuming process. The researcher may peruse through a wide range of evidence, most of which may be useful and some of which might not. The obtained data can be multifaceted and may simultaneously reveal a number of diverse significances.

3.4. INTERNAL TRUSTWORTHINESS

The triangulation approach, that is, the extensive literature review, the personal interviews, and the focus group as theoretical validation permitted the researcher to draw correct and unbiased inferences for this research. This offered the researcher assurance that the conclusions reached were justified based on the data that was gathered as proclaimed by Leedy and Ormrod (2015:336).

3.4.1. External trustworthiness

Because the researcher ensured that the sampling was representative of all coal mining companies in South Africa, the findings should be generalisable to the coal mining industry in Africa by looking at the similarities of the coal mining trends. Furthermore, the focus group as validation ensured that participants provided independent and objective views.

3.4.2. Establishing credibility

The researcher sourced primary data through personal interviews and a focus group from participants who were directly involved in coal mining operations (at the time of research.) These, together with the triangulation approach employed in this study, offered the study credibility. The data gathered from the personal interviews and a focus group as validation of the framework linked to the reviewed literature were discussed to form conclusions and recommendations. Moreover, a consolidation of the research findings from the personal interviews and the focus group was done to ensure credibility.

3.4.3. Dependability

Dependability in qualitative research implies the extent to which the data is constant over a certain period including circumstances. It can be equated to reliability in quantitative research.

3.4.4. Confirmability

Confirmability is the degree to which others agree or corroborate with the findings. This study is unique in that the researcher checked and rechecked and verified the data collected through the theoretical validation of the framework. The researcher also referred to earlier studies of a similar nature in the coal mining industry.

3.4.5. Transferability

Since this study is of qualitative nature, it does not require external validity in that each research is unique and has different settings. However, the transferability of this research is the ability to generalise or the degree to which the outcomes of this research apply to related contexts or settings.

3.4.6. Authenticity

Authenticity is an essential issue in a qualitative study; hence, in establishing authenticity, the researcher sought comfort that the behaviour and assessment of research is honest and reliable, not only regarding the participants' personal familiarities but regarding the wide political and societal inferences of study.

3.5. ETHICAL CONSIDERATIONS

The foregoing section indicated the methodology that was employed in this study; hence, this section discusses ethical issues thereof. When people or animals that have the ability to reason, feel, and familiarise themselves with issues of bodily or mental anguish are targeted by a study, researchers should carefully consider ethical implications based on what they are intending to do (Leedy & Ormrod 2015:120; Wagner *et al*., 2012:89).

Protection from harm: the researcher provided participants with a participation information sheet indicating that the individual particulars of the participants would by no means be disclosed for the duration of or after the duration of the research.

Informed consent: the researcher provided participants with a consent form that was signed up by participants before taking part in the study. The consent forms indicated that the participants had a right to take part or not to take part in this research. Furthermore, respondents had the right to recuse themselves at any phase of this research. Therefore, participants signed the consent forms indicating their willingness to form part of the personal interviews and focus group session.

Right to privacy: the scholar informed the participants in writing that their individual information might never be revealed. Furthermore, fictitious names were utilised in compiling the report of this study to safeguard the personality of the participants.

Honesty with professional colleagues: the researcher reported the findings of this study in a comprehensive and truthful manner, without distorting or deliberately misleading the readers.

Permission to conduct research: the researcher requested permission to conduct research from the coal mining company executives of the targeted coal mining companies in South Africa. The Executives from these coal mining companies confirmed in writing, permitting the researcher to conduct the study. Ethical clearance was sought and granted by the SBL's ethics committee.

3.6. LINKING THE RESEARCH OBJECTIVES AND THE RESEARCH METHODOLOGY

Table 3.1 demonstrates the link between the research objectives and the research methodology that was employed in this study.

Table 3.1: Linking the research objectives and the research methodology

What	Why	How	Where
Determine the information that the coal mining industry is using to make decisions regarding their impact on the environment	This objective determines the existence and efficiency of an EMA framework	Personal interviews, and a focus group as theoretical validation of the framework	Chapter 2
Determine the information needed by the coal mining industry to identify waste	This objective sets the rationale for linking both EMA adoption and EMA implementation	Literature review	Chapter 2
Determine the information to be used by the coal mining industry to reduce cost regarding their impact on the environment	The objective tests the application of EMA in the coal mining industry	Literature review	Chapter 2
Determine how effective existing processes employed by the coal mining industry are to facilitate decisions on environmental impact and related cost savings	This objective determines the extent to which EMA has been discussed in the existing literature	Literature review	Chapter 2 & 4
Establish the benefits of EMA for the coal mining industry	This objective determines the extent to which EMA has been discussed in existing literature	Literature review	Chapter 2
Determine the reasons for possible non-implementation of EMA principles and tools by the coal mining industry	The objective forms a basis to test compliance and governance to King IV report	Personal interviews and focus group	Chapter 2 & 4

What	Why	How	Where
Develop a decision-making framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry	This has been presented in the form of a framework	Methodology and data Collection	Chapter 2 Chapter 2 & 6

3.7. RELEVANCE OF STUDY

This study seeks to develop a decision-making framework to facilitate cost savings and to mitigate environmental impacts in the coal mining industry in South Africa that will also be used in developing countries. Most of the existing frameworks are based on developed countries, hence the need to develop a framework specifically for South Africa.

3.8. SUMMARY

This chapter deliberated on the research methodology that was employed. An extensive literature review, personal interviews and a focus group as validation of the framework were utilised. Steps that were followed to achieve highly productive personal interviews and a focus group were explored. This chapter further explained the research process undertaken and the steps thereof. The data collection methods and data analysis spiral-process including ethical considerations were illustrated. The research objectives and research methodology were linked.

The following chapter presents the findings of the study.

CHAPTER 4 – QUALITATIVE INTERVIEW RESEARCH FINDINGS

4.1. INTRODUCTION

The previous chapter presented the research methodology that was employed in this research, while the current chapter presents the findings of the qualitative interviews conducted. The aim of the aforementioned interviews was to validate and augment the *content*- and *general* propositions developed in Chapter 2, which culminated in a preliminary framework from the literature review. Chapter 5 that follows hereafter is aimed at testing the relevance and applicability of the *associations* in the preliminary framework in Chapter 2.

Collected data was coded and analysed based on Creswell's data analysis spiral-process. A large quantity of data was broken down into smaller divisions of data that were synthesised into meaningful information. This was in line with Creswell (2012:179) data spiral process discussed in Chapter 3. In validating the framework, seven (7) coal mining companies formed part of the focus group. As indicated, the preliminary framework developed in Figure 2.19, Chapter 2 was augmented based on the input gathered from the personal interviews.

4.1.1. Goal of chapter 4

The goal of this chapter is to present the findings of the interview portion of the qualitative survey and to address the following research objectives:

- Determine the information that the coal mining industry is using to make decisions regarding their impact on the environment.
- Establish the information needed by the coal mining industry to identify waste.
- Define the information to be used by the coal mining industry to reduce costs regarding their impact on the environment.
- Establish how effective existing processes employed by the coal mining industry are to facilitate decisions on environmental impact and related cost savings.
- Determine the extent of familiarity of EMA among the participants, and if familiar with EMA, what are the advantages for the coal mining industry?

- Determine the reasons for possible non-implementation of EMA principles and associated tools by the coal mining industry.
- Determine the processes that should be followed by the coal mining industry to effect cost savings and minimise its environmental impact.

These research objectives were posed to the participants as questions (refer to **APPENDIX A: INTERVIEW PROTOCOL**) and were addressed during the personal interviews, culminating in validating and augmenting the content- and general propositions in the preliminary framework. Owing to its size, the complete framework is shown only at the end of Chapter 5, while only the validated and augmented content of the *entities* (rectangles or boxes) in the Figure 2.19 framework are shown at the end of this chapter.

4.1.2. Layout of chapter 4

The layout of the chapter is as follows: In Section 4.2 the goal of this chapter is discussed; this is followed by the data saturation in Section 4.3, and the presentation, interpretation and discussion of findings in Section 4.4. The revised content of each entity (rectangle/box) are shown in Section 4.5. The chapter concludes with a summary in Section 4.5.

4.2. SATURATION POINT

In analysing the data, the researcher constructed a table (Annexure-H) with the themes as they emerged during each interview indicating the point at which no new themes emerged. This table assisted the researcher to identify the saturation point since there were no new themes that were emerging.

4.3. PRESENTATION, INTERPRETATION, AND DISCUSSION OF FINDINGS

This subsection comprises the presentation, interpretation, and discussion of the findings of this research starting with the demographic data of the participants.

4.3.1. Demographic data

In the following sub-sections, the gender, years of work experience and managerial level are discussed.

4.3.1.1. Gender of participants

Figure 4.1 demonstrates the disaggregation of the interviewees by gender.

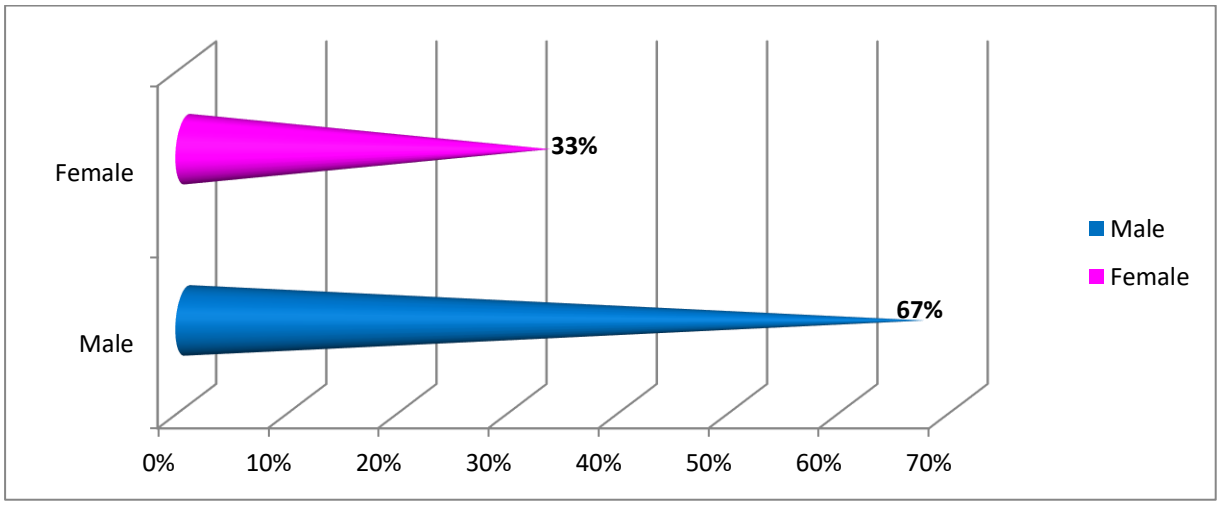

Figure 4.1: Gender of participants

Figure 4.1 demonstrates that more males (67%) than females (33%) participated in the interviews. The fact that more males than females participated in the study may be intrinsic to the coal mining industry in which more males than females tend to enter as a career.

The above division is consistent with the view by Martin and Barnard (2013:7) who argued that despite concerted efforts by coal mining companies to employ more women, they experience oppressive behaviour from male colleagues. Furthermore, one should note that the specific working conditions in the coal mining industry may not be appealing to some women.

4.3.1.2. Years of work experience

Figure 4.2 shows the work experience of the participants. The work experience of the interviewees indicates the depth in knowledge and understanding of the coal mining industry.

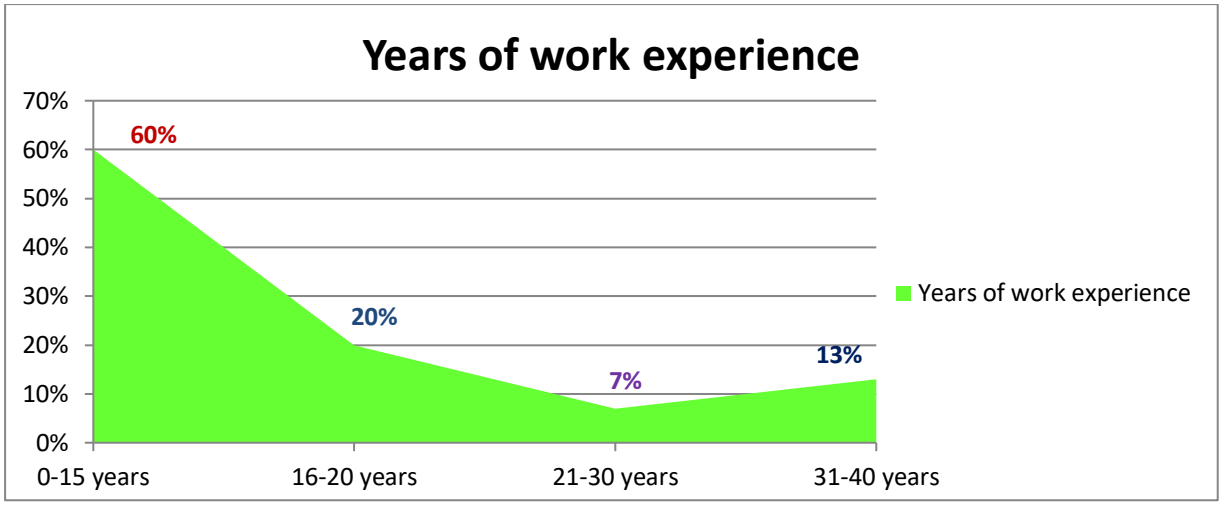

Figure 4.2: Years of work experience

Figure 4.2 indicates that most of the participants (60%, n=60) had work experience ranging from 0 up to 15 years, with 7% having work experience of 21 to 30 years. However, 20% of the interviewees had work experience ranging from 16 to 20 years whilst 13% had work experience ranging from 31 to 40 years.

The years of work experience reveal the level of knowledge and experience of the participants in the coal mining industry. Furthermore, it demonstrates that participants who formed part of this research had ample knowledge (at the time of the interviews) and understanding of the industry. It is evident from the findings that the respondents have been in the coal mining industry for a period ranging from 1 year up to 40 years.

4.3.1.3. Managerial level of the participants

Figure 4.3 shows the managerial level of the participants. The study targeted all levels of employees within the coal mining industry to ascertain different views from the participants and to address possible bias of the responses.

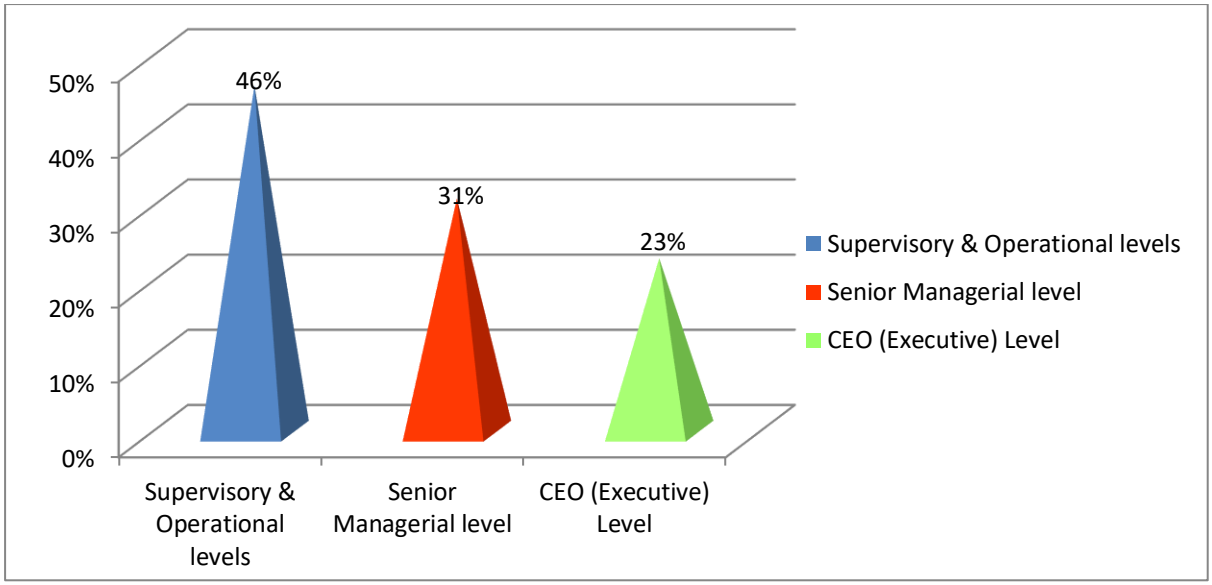

Figure 4.3: Managerial level of participants

As depicted in Figure 4.3, most of the respondents (46%, n=46) were at supervisory and operational levels at the time of the research. A significant 31% of the participants were at senior managerial levels whilst 23% of the respondents were Chief Executive Officers (CEOs) or executives. The researcher postulates that the managerial levels indicate the participants have been exposed to the coal mining core business for a substantial time. Consequently, they understand and are well versed with the coal mining processes and procedures.

IFAC (2005:26) also alludes to the fact that companies need to ensure that environmental managers, technical experts, and accountants work together to provide the full picture of environmental issues and the related costs and benefits that are relevant for making an investment decision. It is also important to distinguish between fixed and variable environmental-related costs in investment decision-making. The researcher is of the view that (naturally) CEOs and senior managers should work together to address environmental matters to benefit their companies.

However, some participants from these groups were divided on certain questions. For instance, they disagreed that existing processes employed by the coal mining industry to make decisions are effective since these did not mitigate environmental impacts. Others indicated that coal mining companies are more focused on the bottom-line rather than saving the environment. Possible reasons for disagreement and non-implementation of EMA were a lack of knowledge and understanding of the subject matter (refer to Section 4.4.5).

4.4. ADDRESSING THE RESEARCH OBJECTIVES OF THE STUDY

In the following sub-sections, the information that the coal mining industry's need for various activities is discussed. The efficiency of existing processes utilised by the coal mining industry to facilitate decisions in terms of their environmental impacts and related costs and their familiarity with EMA are portrayed. The reasons for possible non-implementation of EMA principles and tools by the coal mining industry are discussed. Processes that ought to be followed by the coal mining industry to make decisions in terms of their environmental impacts and related costs are identified. The chapter concludes with content of the entities that have been validated, augmented entity content as indicated in Figure 4.5, emanating from the interviews, and a conclusion to the chapter.

4.4.1. Research objective 1: Determine the information that the coal mining industry is using to make decisions regarding their impact on the environment

The participants pointed out that the following information is needed to take environmental decisions:

- EIAs (Environmental Impact Assessments), authorisations and Environmental Management Plans (EMPs).
- Project designs and research studies; environmental baseline studies derived from specialist reports; and case studies;
- Advice from coal mining consultants and shareholder's views, environmental legislation, and regulatory requirements;
- NEMA 107 of 1998 which seeks to promote co-operation regarding environmental governance by establishing principles for decision-making on matters affecting the environment.

The above is consistent with the view by Stein, Levetan, Christie, Frittelli and Nathan (2010); and Mathee (2011:38) who argued that the foremost legislation relates to the NEMA 1998 which provides for co-operative governance and decision-making. An example are matters affecting the environment based on the best international principles for sustainable development and integrated environmental management.

Other participants referred to information from NGOs and internal audits such as risk, safety, governance, and analysis. Complaints from the local communities, monitoring information, best practice guidelines- both local and international, environmental guidelines, and pollutant release information such as AMD (Acid Mine Drainage) were mentioned. Attention to occupational hygiene analysis, cost impact analysis, and legislative frameworks and international frameworks was called for. Ntalamia (2017:6) opined that companies are faced with distinctive difficulty since their activities might cause higher environmental costs.

One of the participants mentioned that:

> *"Environmental impact assessments (EIAs) including specialist studies and project designs are mostly used to make decisions. Environmental management plans (EMPs), environmental legislation, regulatory requirements, engagement with mining consultants and research institutions, community complaints and NGOs, cost impact assessments, monitoring information and shareholder's views to make decisions."*

The researcher postulates that although there are legislation and policies for mitigating environmental impacts, a need remains for controlling and monitoring procedures for assessing the level of compliance by the coal mining companies.

4.4.2. Research objective 2: Establish the information needed by the coal mining industry to identify waste

Some participants were non-specific regarding what information is needed by the coal mining industry to identify waste. However, most of the participants mentioned the definition and classification of waste in terms of the National Environmental Management: Waste Act, 59 of 2008. Waste is classified into domestic, general, and hazardous, the latter defined as waste with organic or inorganic elements or mixtures that might have a detrimental effect on human health and the environment.

Other respondents mentioned chemical analysis and waste classification information, material characterisation, standards, and legal specifications/sampling. Additionally, static and geochemistry aspects, specialist studies focussing on contaminated land and polluted sources (source pathway receptors), collected data and models, waste samples, and process information were also mentioned.

The above concurs with the view by Qian *et al.* (2011:93) who argued that the growth of EMA in Australia was influenced by the ability to identify, classify and manage waste.

Other participants mentioned sampling analysis (proximate and ultimate analysis) and the number of solids and liquids into and out of the plant materials of all streams as necessary information to obtain. Data from the mining production on percentage mined and percentage process of generated waste, percentage of methane, understanding of the environmental legislation, AMD, coal quality, and potential product beneficiation technologies were also mentioned.

Despite the above suggestions, Kirsch (2010:88) claimed that contamination from a solitary mining project may affect hundreds of square kilometres. Therefore, AMD might cause surroundings to be unreceptive to biological lifespan for centuries. Consequently, companies are encouraged to carefully manage the release of AMD into the environment. Other participants raised the challenge when a local input and the impact of a single operation are assessed, wherein neither the cumulative impact nor the effect of other industries and human activities are considered.

Gavriletea (2017:19) agreed that coal mining companies should be cognisant of environmental effects of their operations. They should think along the lines of saving environmental costs and to integrate these as a part of operational costs. Companies should focus on determining, monitoring, and decreasing undesirable environmental effects on every environmental activity and executing relevant mitigations to save the environment.

One of the participants stated:

> *"Input from [the] technical survey department, classification of waste in the coal mining industry, [and] operational waste usually applies [apply] LEAN principles and market waste, that is, what cannot be sold."*
>
> *"[Information needed is] Chemical analysis and classification information, coal grade classification material characterisation of all streams standards and legal specifications as well as sampling analysis information."*

The researcher postulates there should be consistency in terms of information needed by the coal mining industry to identify waste. It should be compulsory for coal mining companies to comprehend and appreciate their environmental

responsibilities of mitigating environmental degradation. Furthermore, they ought to understand and be aware of any critical information for the identification of waste.

4.4.3. Research objective 3: Define the information to be used by the coal mining industry to reduce costs regarding their impact on the environment

Respondents indicated most of the information needed was already in place and being used by the coal mining industry in reducing costs regarding their impact on the environment. They also mentioned there is a need for leading indicators and suggestive tools to facilitate the coal mining industry proactively putting corresponding measures in place. These measures may well be less expensive than reacting or mitigating environmental impacts later on; by minimising environmental impacts earlier, their mining costs ought to be reduced in the long run.

Many of the participants pointed to project designs aligned to environmental considerations and research work on mitigation measures. Some of the other issues that were alluded to include the identification of current impacts, planning and budgeting of environmental impacts, legal requirements to avoid legal cases, and quantifying liabilities. Proper planning and execution from the production department to environmental and technical departments in line with environmental requirements including proper discharge of liquid effluent, were also mentioned. Further options that came to the fore include recycling, reusing and generating zero waste such as dry cooling beneficiation, and operational costs in terms of changing the downtimes of operations.

The above discussions are consistent with using MFCA (refer to Chapter 2) as a tool that offers an opportunity for companies to capture waste-cost information accurately beyond that provided by conventional accounting systems. Waste generated by companies impacts on both costs and the environment in several ways. For instance, lost income through a combination of lost materials and disposal costs essentially reducing the amount of wasted materials, is an effective way of improving resource efficiency. Accounting systems such as MFCA can be used to capture and draw decision-makers' attention to the full costs of waste (Fakoya & van der Poll, 2013:136).

Some respondents indicated that waste is usually considered as zero cost material since there is no price attached to it. This is consistent with IFAC (2005:19), stipulating that companies that decrease the usage of water might reduce the amount of effluent discharges through wastewater generation through environmental activities, as well as costs of an internal effluent management plant set up predominantly for compliance reasons.

Interviewees also mentioned spatial data, regional planning, improved benchmark data and new technology solutions, accurate quantification of the impact, best practice guidelines, integrated data needed from suppliers to understand the cost drivers, mining methods, safety measures, and risk management training as options to mitigate coal mining costs.

Some of the participants responded as follows to the information needed:

> *"Options of recycling, reusing, and generating zero waste. For instance, dry cooling beneficiation, waste is usually considered as zero cost material only when market value for waste streams is found, is then that we qualify the processing cost involved, environmental variables (climate change, ecology and vegetation type.)"*

> *"Spatial data, regional planning data, improved benchmark data and new technology solutions, accurate quantification of the impact and best practice guidelines. Integrated data needed from suppliers to understand the cost drivers, mining methods, safety measures and risk management training. Operational costs in terms of changing current operations downtime, proper planning and execution from production department to environmental and technical departments."*

The researcher argues that coal mining companies should understand their environmental footprint to reduce costs regarding their impact on the environment. These companies should also strive for operational efficiency using advanced technologies in the coal mining industry.

4.4.4. Research objective 4: Establish how effective existing processes employed by the coal mining industry are to facilitate decisions

In the following sub-sections, it is established how effective existing processes employed by the coal mining industry are to facilitate decisions in terms of their environmental impacts, and what the related costs are.

4.4.4.1. Their environmental impacts

Most of the participants had few or no facts at hand regarding the efficiency of existing processes that are currently being utilised by the coal mining industry; consequently, their responses were sparse. However, a few respondents alluded to the integration of environmental management with operational management. Water liability was mentioned as a challenge for long-term use and availability, hence continuous improvement should be developed to raise environmental performance over time.

Other participants reiterated that environmental impacts take a punitive reputational view. If reputation impact is greater than revenue, then it is worth mitigating any adverse effects on the environment. Respondents indicated that continuous improvement raises the environmental performance. However, most of the participants were not sure or clear regarding the efficiency of existing processes that are employed by the coal mining industry regarding their environmental impacts. However, they indicated there may well be reasonable room for improvement.

The above discussions are consistent with Kim (2002:56) who argued that while it may not be possible to eliminate all the adverse impacts that pollutants might have on water, air, and soil, they should at least be minimised. Costs that are incurred to eliminate or minimise environmental impacts of pollutants generated in the production are referred to as pollution treatment costs. Examples include wastewater treatment costs, the operating costs of an incinerator, and depreciation costs of treatment facilities.

One of the respondents mentioned that:

> *"Water liability remains a challenge for long-term processes. Therefore, continuous improvement must be developed to raise environmental performance over time. Environmental impacts take a punitive reputational*

frame; if reputation impact in greater than revenue, then it is worth mitigating the environment."

"I have no facts and figures about this, no answer."

The researcher opines that based on the findings of the survey, it is concerning that some of the participants have little or no information on how effective existing processes employed by the coal mining industry are in facilitating decisions in terms of their environmental impacts.

4.4.4.2. Related cost-savings

Most participants mentioned cost-saving aspects of water saving strategies and the importance of having a dedicated budget for environmental impacts. Proper budgeting and procurement procedures should be in place. Topsoil shortfall and liability backlog were reported to be a challenge of post-mine closure. Some respondents maintained that the system is currently not very effective, yet it can become environmentally sustainable if coal mining companies develop and integrate practices that reduce environmental impacts. Other interviewees noted that current processes that are not effective can, however, become environmentally sustainable if they (coal mining management) develop and integrate practices that can reduce the environmental footprint (impacts) and costs.

Other participants were of the view that there are often cost savings in the shorter term but higher liabilities in the longer term. The related costs do not always include the full LCC (refer Chapter 2) such as long-term liabilities. This is contrary to the assertion by Fakoya and van der Poll (2013:136) who opined that MFCA as a tool for EMA provides prospects for the accounting function to record waste-cost information precisely further than that delivered by environmental accounting systems. Discarded material created by the companies affects both costs and the environment in different ways. One of the respondents stated that:

"Proper budgeting and procurement procedures should be in place. Topsoil shortfall and liability backlog is still an issue and it will affect the mine post-closure. Current processes are not very effective but can become environmentally sustainable if (coal mining companies) develop and

integrate practice that can reduce the environmental footprint (impacts) and costs."

The researcher postulates that coal mining companies should close the gap between that which is known (basic knowledge) and implementation (mitigating environmental impacts such as pollution and contamination of water through mining activities.)

4.4.5. Research objective 5: Determine familiarity with EMA

Figure 4.4 demonstrates the familiarity and non-familiarity of the coal mining industry with the concept of EMA in South Africa.

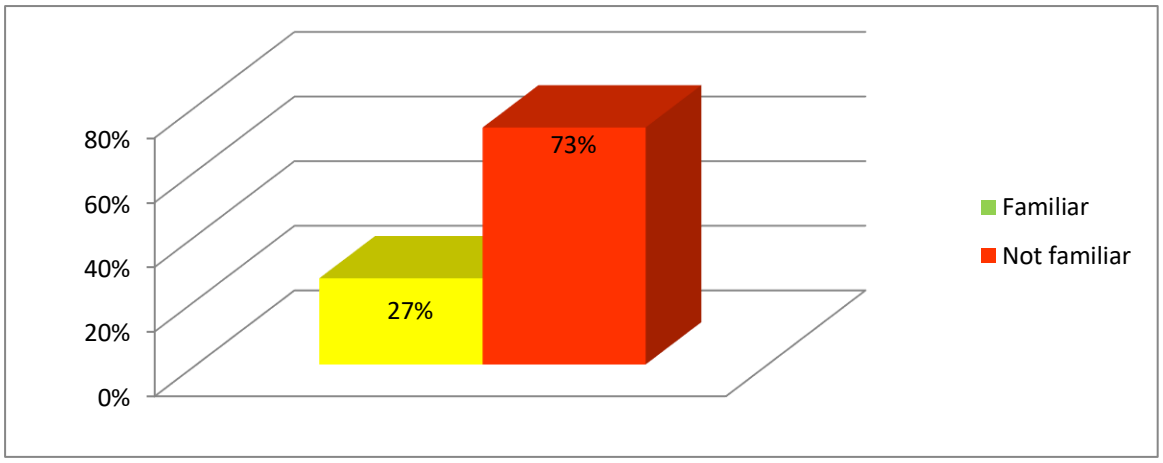

Figure 4.4: Familiarity with EMA

Of the total number of 15 participants interviewed, 73% indicated that they were not familiar with EMA whilst 27% indicated they were familiar with EMA. This is in line with the assertion by Burritt (2005:19) who observed that not much is known regarding EMA, hence the promotion of EMA is being implemented by international, national, and local government bodies and some educational institutions to embrace EMA. Consequently, EMA is being promoted by groups such as the United Nations Division of Sustainable Development (UNDSD, 2001) and United Nations Environment Programme (UNEP, 2015).

Saeidi and Sofian (2014:30) suggested that managers in environmental management need to be advised and encouraged to employ EMA. This could be achieved by providing managers with additional tentative proof of the prospective usages and profits of EMA on how coal mining companies perform in relation to environmental

compliance. One of the participants indicated that EMA could drive the industry into the right direction; however, the governance of EMA is still in its infancy.

Two of the respondents indicated:

> *"EMA is a new concept and I am not familiar with it."*

> *"Not familiar with EMA but I assume that it relates to valuing the ecosystem."*

The researcher postulates it is disconcerting that some of the participants are not aware of EMA. This indicates the coal mining industry might be taking uninformed decisions that negatively affect the environment. Naturally, coal mining companies would not adopt and implement EMA if they are unfamiliar with the concept.

4.4.6. Research objective 6: Determine the benefits of EMA for the coal mining industry

Some of the key benefits of EMA for the coal mining industry that were mentioned by the participants include:

- Better understanding of the trade-offs between economic development and the environmental impacts;
- Better decision-making and protection of the environment from pollution; enabling coal mining companies to minimise waste which impacts on the environment and improves LCC;
- Improved cost benefit analysis, optimised environmental spending to prevent exceeding the budget, harmonisation of production and environmental management work;
- Identification of resources, activities and impacts of mining operations as well as related financial impacts;
- Being proactive in environmental management issues.

One of the respondents stated:

> *"Some of the key benefits of the coal mining industry include better decision-making, protection of the environment from pollution, enables coal mining companies to minimise waste which impacts on the environment, improves life cycle costing."*

The above findings are consistent with Bracci and Maran (2013:541) who argued that pro-active environmental management would search for the reciprocal compatibility between the company and its environment. That said, it would require changing thought processes, recognition of the larger concept, acceptance of uncertainty and ambiguity of a company's potential impact, challenging of the world view, emphasising inclusion of more external stakeholders' view, and incorporating cost of externalities.

Bracci and Maran (2013:538) claim in order to measure environmental compliance, a distinction should be made between prevention and control costs, which companies have to pay in order to prevent the environmental degradation from mining operations and costs associated with mitigating environmental impacts. They elaborate that the distinction is different from the accounting distinction within a company: the environmental cost for a company will vary its classification according to the relevant aim of the economical measurement; communication to stakeholders, communication to the banks/other funders, internal communication, efficiency control of the productive processes, and evaluation of the future responsibilities due to environmental risks.

The researcher purports that coal mining companies should identify and compare the pros and cons of their mining activities. This will allow these companies to be innovative in improved business processes and avoid activities that may lead to hidden costs in the future.

4.4.7. Research objective 7: Determine the reasons for possible non-implementation of EMA principles and tools by the coal mining industry

Most of the participants indicated that:

- Costs may be incurred in the long run if concurrent rehabilitation or environmental management is not correctly implemented. This involves re-evaluating associated costs, escalation of costs which impacts on the bottom line, and related environmental penalties;
- There are insufficient funds for rehabilitation and related liabilities;
- It is not a legal requirement to implement EMA at an operational level in the coal mining industry but voluntary;

- The ultimate focus is on production and not on the environmental impacts. This is mostly evident especially in the small coal mining companies that are not listed on the Johannesburg Stock Exchange (JSE);
- Governance frameworks are at infancy regarding ISO standards, specifically the monitoring and reporting of standards;
- There are challenges associated with implementing EMA and the costing thereof.

Respondents also indicated a/an

- Lack of awareness, knowledge and understanding of EMA;
- Lack of enforcement by authorities;
- Lack of effective environmental strategies;
- Ignorance by coal mining companies, coupled with irresponsible behaviour.

One of the interviewees reported:

> *"My assumption is that there are existing perceptions and there are high costs related to implementing EMA which affect the bottom line."*
>
> *"The ultimate focus is on production and not on the environmental impacts. This is mostly evident especially in the small coal mining companies that are not public listed companies or not listed in the JSE."*

The above discussions are contrary to the argument by Jasch (2006:1195) who demonstrated that EMA may be implemented in a day (refer to Chapter 2). A crucial task is to ensure that all relevant and significant costs are considered when making business decisions. In other words, corporate environmental costs are a subset of the larger cost universe that is vital for good decision-making. Environmental costs are part of an integrated system of materials, energy and money flows through a corporation, and are not a separate type of cost. Practising EMA is simply conducting improved, more comprehensive MA while wearing an environmental hat that exposes hidden costs. Therefore, the focus of material flow accounting is no longer assessing the total environmental costs, but on a revised calculation of production costs based on material flows including energy and water.

EPA (1995:7) also contended that uncovering and recognising environmental costs associated with a product, process, system, or facility is important for good

management decisions. Achieving goals such as reducing environmental costs, increasing revenues, and improving environmental performance requires paying attention to current, future, and potential environmental costs. How a company defines an environmental cost depends on how it intends to use the information (for instance, cost allocation, capital budgeting, process/product design, other management decisions, etc.) and the scale and scope of the exercise. Moreover, it may not always be clear whether a cost is environmental or not; some costs fall into a grey zone or may be classified as partly environmental and partly not. Whether or not a cost is environmental may not be critical; the goal is to ensure that relevant costs receive appropriate attention.

Kamruzzaman (2012:2) argued that most companies focus more on generating profit than mitigating their environmental impacts. Consequently, governments, non-governmental institutions and the communities at large are progressively placing a burden on the companies to be more receptive in considering the environment and to put significant financial resources and energy in place to protect the environment in which a coal mining company operates. The matter of preserving the environment has been considered globally in past decades that has in turn made it necessary for businesses to reconsider their accounting practices and accentuate on being more accountable for the environment and other relevant matters in their annual reports and management decisions.

4.4.8. Research objective 8: Determine the processes that ought to be followed by the coal mining industry to make decisions

In the following sub-sections, the environmental impacts and related costs are discussed.

4.4.8.1. Environmental impacts

The respondents called for the following:

- More detailed reviews and identification of environmental impacts at the beginning and continuous provision of mitigation plans;
- Identification of risks, environmental hazards and impact analysis;
- Existing legislative instruments that need to be enforced and adhered to such as EIAs, EMPs, and the NEMA;

- Integration of environmental requirements from planning to inception of the coal mining project;
- Implementation of sustainable coal mining operations and evaluations and ongoing environmental monitoring;
- Proper consultation with environmental personnel in decision-making processes;
- Improved metallurgical and power stations processes;
- Determining the impact on communities and associated costs;
- Reduction of CO_2 emissions
- Implementation of MFCA and DEA processes.

One of the participants stated that:

> *"The integration of environmental requirements from planning to inception of the coal mining project; implementation of sustainable mining operations and sustainability evaluations; and ongoing environmental monitoring, and proper consultation with environmental personnel in decision-making processes."*

The above are consistent with the view by Bagur-Femenias *et al.* (2013:55); and Garzella and Fiorentino (2014:82) that an investment in EMA generally necessitates a substantial financial injection and the revenues are more or less immaterial, hence these are stretched beyond a specified future time point. The adoption of EMA might be due to social structural influences and company contextual influences, which motivated the development of EMA for waste management. However, in most instances, the adoption of EMA was because of a directive from senior management and shareholders. This could be achieved by integrating EMA into corporate policies and business plans which are later turned into KPIs (Ramakrishnan *et al.*, 2015:43).

Researchers (Schaltegger *et al.* 2000:18; Burritt, 2004:14) argued that environmental accounting systems measure quantities in physical units and provide processes to regulators for managing compliance within the rules. In addition, such accounting processes are essential for the calculation of green taxes such as CO_2 or volatile organic compounds (VOC) discharge tax. Furthermore, the National Treasury of South Africa (2017:9) reported that carbon tax should be charged based on the total summation of the GHSs of a taxpayer in respect of a tax period. This is expressed as

the CO_2 equal of those GHG releases resultant from fuel incineration and mining procedures, and discharges in line with the release aspects calculated in agreement with a reporting practice sanctioned by the DEA.

4.4.8.2. Related costs

Many participants mentioned the importance of the use of modern tools and involvement with all stakeholders, the appointment of competent environmental staff, a dedicated environmental budget, and provisions required for post-mine closure. Proper procurement procedures and processes, including financial modelling of projects, moving away from tick-box exercises, thinking alternative industries, recognising the value of water quality analysis, and promoting drive patriotism were also mentioned.

Other respondents indicated full-cost accounting and the use of technology to assess long-term cost impacts and cost savings to be vital. They also called for a cost benefit analysis of alternative methods, a change to LCC to reflect the operational cost of coal per ton, and the use of full LCC over a period of 7 to 10 years. Respondents furthermore called for an upfront cost benefit analysis including the cost of rehabilitation into net present value (NPV), improved consultancy on cost savings, a decrease in the number of workforce (for cost saving, but having a detrimental effect in employees losing their jobs); and improved estimates on rates.

One of the respondents listed the following:

> *"A dedicated environmental budget, provisions required for post mine-closure activities, proper procurement procedures and processes including financial modelling of projects. Moving away from tick-box excuses, think alternative industries, value water quality analysis, and drive patriotism."*

The above are consistent with the view by Kim (2002:62) who argued that when environmental benefits are matched with the corresponding costs to the greatest extent possible, environmental costs result in the elimination or reduction of environmental impacts, or in the improvements in the environmental performance of a company. The scope and the reporting period of environmental costs may well translate into environmental benefits. These environmental benefits can be measured in either physical units or monetary units. While environmental burdens are measured,

and changes therein are (probably) best measured in physical units, economic benefits from environmental measures are taken by mining companies. These include revenues and cost savings or avoidance, again (probably) best measured in monetary units.

Section 4.5 which follows next confirms how the findings from the interviews validate many of the content- and general propositions (that is the content of the entities) in Figure 2.19, the preliminary framework. Yet, a number of additional components and aspects emerged. These are considered in Section 4.6 thereafter.

4.5. SURVEY VALIDATION OF ASPECTS OF PRELIMINARY FRAMEWORK

This chapter set out to validate the content and general propositions established in Chapter 2 to construct the content of the entities (boxes) in our preliminary framework in Figure 2.19. This was conducted through the setting of a number of objectives to be addressed in the interview schedule conducted with 15 participants in the coal mining industry.

Numerous aspects for each of the six (6) entities in the framework were validated. Those validated are indicated in the 2nd column of Table 4-1.

Table 4.1: Validated components of entities

Entity	Component
SUBJECT FIELD	EMA ❖ Management & shareholder directives
TOOLS (METHODOLOGIES)	❖ Tools o MFCA o LCC (Life-Cycle Costing)
REGULATORY	❖ Government legislation ❖ NEMA ❖ Carbon tax
PURPOSE	❖ Environmental aspects o Water Pollution (reduction) ❖ Waste management

Entity	Component
	○ Waste reduction ○ Land Pollution (reduction) ❖ Decision-making ❖ Cost impacts ○ Cost Savings ○ Profit Margin
ENVIRONMENT (STAKEHOLDERS)	❖ Natural environment ❖ Communication to stakeholders
IDENTIFICATION OF RISK AND MITIGATION	❖ Risk – check for more

4.6. ASPECTS THAT EMERGED FROM THE SURVEY

New aspects, augmenting the components of the entities in the preliminary framework, emerged from the survey. Consequently, the preliminary framework may be augmented with the findings from the above interview-based survey.

The full framework will be given at the end of Chapter 5, following the findings from the focus group, but in the interim the components in the entities are augmented as indicated in Figure 4.5.

SUBJECT FIELD

- Auditing
- EMA – *pC5*
  - PEMA – *pC10*
  - MEMA – pC10
- Financial Modelling
- Environmental Management (EM)
- Operations Management (to be integrated with EM

PURPOSE

- Environmental - *pC2*
  - EIA
  - Reduce water pollution – *pC2*
  - Improved health – *pC3*
  - Spatial & Regional Planning
- Waste reduction – *pC8*
- Decision making – *pC15*
- Performance – *pC16*
- Improved costing – *pC17*
  - Budgeting
  - Depreciation Costs
  - Operational Costs
  - Pollution Treatment Costs
  - Funding for Rehabilitation
  - Profit margin – *pC17*
  - NPV
  - Savings of raw materials – *pC18*
- Future Possibilities

TOOLS (METHODOLOGIES)

- Advanced Technologies
- Best Practices
- Efficient Processes
- Metallurgical & Power Stationing
- Mining Methods
- MIS – *pC1*
- MFCA – *pC7*
- LCC – *pC11*
- Strategy – *pC14*
  - Green
- Procurement Procedures
- Alternative Methods

ENVIRONMENT (STAKEHOLDERS)

- Environmental Footprint
- SLO – *pC6*
- Investors (external environment) – *pG1*
- Employees (internal environment) – *pG1*
  - Competent Staff
  - Reduced Workforce
  - Drive patriotism
- Unions – *pG1*
- Efficient communication – *pG2*
- Natural environment – *pC2* (cf. above)

REGULATORY

- EMPs
- Governance Frameworks
- Health regulations – *pC4*
- ISO – *pC9*
- EM Act / Government legislation – *pC12*
  - DEA
  - Green Taxes
- GRI guidelines – *pC12*
- King IV – *pC12*
- Carbon tax – *pC13*
  - CO_2 Emissions

RISK ASPECTS – *pC19*

- AMD
- Post-mine Closure
- Safety
- Ongoing Monitoring
- VOC

	Legend: • AMD – Acid Mine Drainage • DEA – Department of Environmental Affairs • EIA – Environmental Impact Assessment • EM – Environmental Management • EMPs – Environmental Management Plans • VOC – Volatile Organic Components	

Figure 4. 5: Augmented components of entities

4.7. SUMMARY

The components of the entities in the preliminary framework developed in Figure 2.19 were validated in this chapter through 15 qualitative interviews. Many of the existing components were confirmed, but numerous new components were added, as indicated in Section 4.6.

In determining information that the coal mining industry is using to make decisions with regards to their impact on the environment, the findings indicated that EIAs, authorisations, and EMPs as well as legislation were being used. With regards to establishing the information needed by the coal mining industry to identify waste, the findings indicated that a smaller number of the interviewees were not specific as to what information is required by the coal mining industry to identify waste. However, most of the participants mentioned the definition and classification of waste in terms of the National Environmental Management: Waste Act, 59 of 2008.

In defining the information to be used by the coal mining industry to reduce costs regarding their impact on the environment, most participants indicated project designs aligned to environmental considerations, planning and making provision for environmental budgets. In establishing the efficiency of existing processes employed by the coal mining industry to facilitate decisions in terms of environmental impacts, the findings indicated the need for the integration of environmental management with operational management as well as water saving strategies (related cost-savings.) The findings established that a higher percentage of participants were not familiar with EMA whilst a few were familiar with EMA.

In determining the benefits of EMA for the coal mining industry, the findings indicated that there was better understanding of the trade-offs between economic development

and the environmental impacts as well financial savings. However, with the regard to determining reasons for possible non-implementation of EMA principles and tools by the coal mining industry, it was established that most coal mining companies are reluctant to implement EMA due to cost implications. For instance, there are no budgets dedicated for environmental costs. With regards to determining the processes that ought to be followed by the coal mining industry to make decisions, the findings indicated that identification of risks, environmental hazards, impact analysis, and current legislative instruments needed to be enforced and adhered to, such as EIAs and EMPs and the NEMA. However, in determining related costs, the findings established the need to appoint competent environmental staff, provisions required for post-mine closure activities, proper procurement procedures and processes including financial modelling of projects as well as moving away from tick-box exercises.

The following chapter presents the findings of the focus group that was conducted to validate the associations in the rudimentary Figure 2.19 framework.

CHAPTER 5 – FOCUS GROUP VALIDATION OF FRAMEWORK ASSOCIATIONS

5.1. INTRODUCTION

The foregoing chapter presented the findings from the personal interviews, and on the strength of these, the *components* of the six entities were enhanced as indicated in Figure 4.2. The current chapter provides a validation of the *associations* among the entities through a focus group session that was conducted at the CSIR in Pretoria on 13 February 2019. In validating the said associations in the framework, the researcher approached Coaltech, which is a research institute (body) that manages and coordinates coal mining companies. Permission was granted for the researcher to present the framework and engage with the focus group. The interviews described in Chapter 4 were conducted independently of the focus group activity. Consequently, the framework presented to the focus group was Figure 2.19, i.e. the one at the end of Chapter 2.

5.1.1. Goal of Chapter 5

The goal of this chapter is to present the findings based on the focus group to validate the associations in the framework. These findings have been consolidated with the ones from the personal interviews in Chapter 6. Following the enhancement of the entities in Chapter 4 and the validation in this chapter, final framework is presented at the end of this chapter.

5.1.2. Layout of Chapter 5

The layout of this section is as follows: ethical considerations are discussed in Section 5.2, followed by Section 5.3 which considers demographics, gender, years of experience, and managerial experience. Section 5.4 portrays the key findings of the focus group, followed by a further discussion in Section 5.5. Section 5.6 presents the final decision-making framework and Section 5.7 concludes the chapter with a summary.

5.2. ETHICAL CONSIDERATIONS

The researcher provided the participants of the focus group with consent forms, which were signed by all 12 respondents. There were no objections to participate in the focus group. The researcher also informed participants that they had the right to participate or not in the study and to withdraw at any stage from the focus group. They were also informed that the aim of the focus group session was to validate the associations (and implicitly the components) of the preliminary framework and that the findings were to be used for academic purposes. Furthermore, the findings of the study would be provided to the participants upon receiving a written request.

5.3. PRESENTATION, INTERPRETATION, AND DISCUSSION OF FINDINGS

This subsection comprises the presentation, interpretation, and discussion of the findings of this research starting with the demographic data of the focus group.

5.3.1. Demographic data

The focus group comprised of twelve participants from seven (7) coal mining companies. The focus group was conducted at the CSIR- Pretoria building 33, Kingfisher boardroom on 13 February 2019 at 10:00 am. Participants were from all levels of management, namely operational and supervisory levels, senior management, and CEO levels.

5.3.1.1. Gender of participants

Figure 5.1 shows the gender of the participants who were interviewed, all from the coal mining industry.

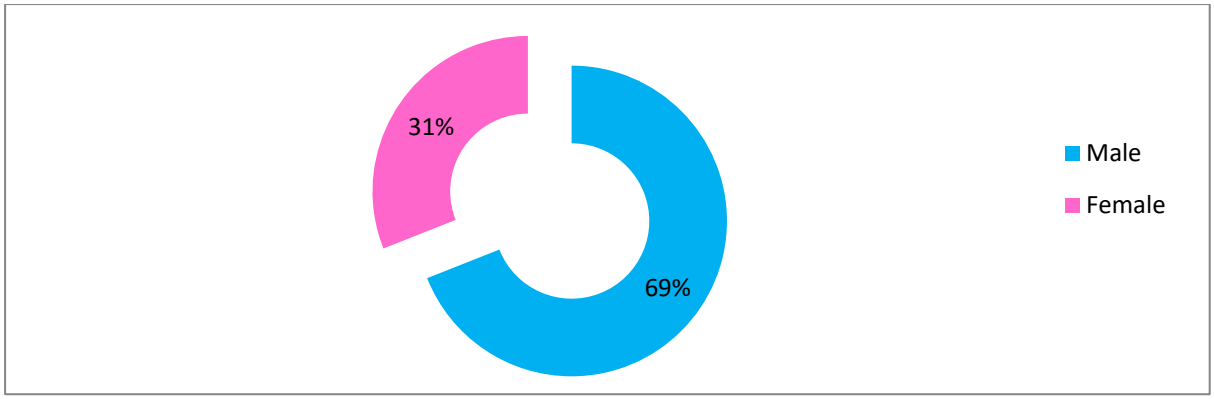

Figure 5.1: Gender of participants

Similar to the finding in Chapter 4, Figure 5.1 demonstrates that more males (69%) than females (31%) formed part of the focus group as validation of the developed framework. Also, as argued before, the fact that more males than females participated in the study may be intrinsic to the coal mining industry in which more males than females tend to enter as a career. This finding agrees with the view by Martin and Barnard (2013:7) who argued that despite concerted efforts by coal mining companies to employ more women, they experience oppressive behaviour from male colleagues. Further to this, one should note that the specific working conditions in the coal mining industry may not be appealing to some women.

5.3.1.2. Years of work experience

Figure 5.2 shows the work experience of the participants who formed part of the focus group. The work experience of the respondents provides the depth in knowledge and understanding of the coal mining industry.

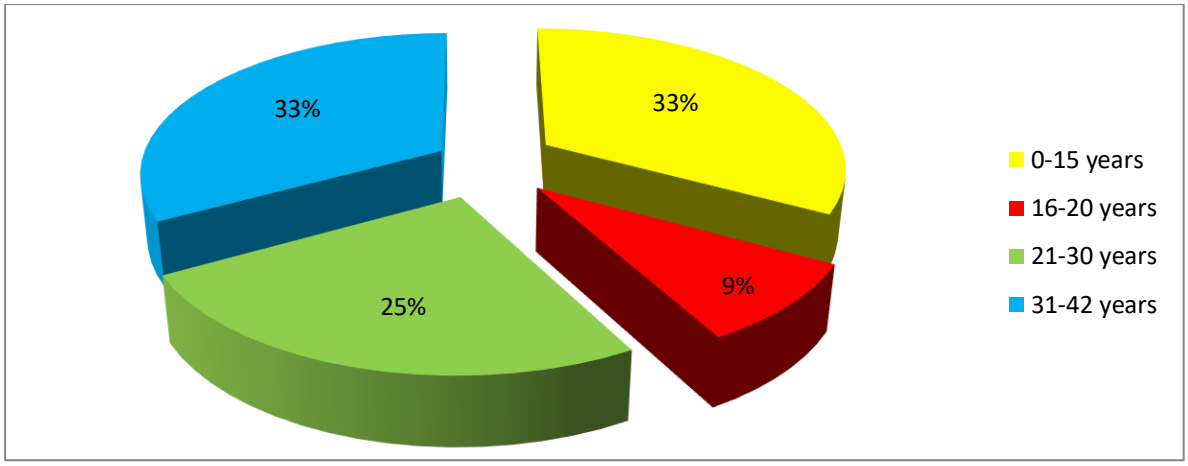

Figure 5.2: Years of work experience

As shown in Figure 5.2 it can be demonstrated that a similar percentage (33%, n=33) of participants had work experience ranging from 0 to 15 years and 31 to 45 years, respectively. However, 25% of the respondents had work experience ranging from 21 to 30 years, whilst a lower percentage, 9%, had work experience ranging from 16 to 20 years. The years of work experience shows the depth of knowledge and experience of the participants in the coal mining industry. Furthermore, it confirms that participants who formed part of the focus group had ample knowledge and understanding of the industry. It is evident from the findings that the respondents have been in the coal mining industry from 1 year up to 42 years.

5.3.1.3. Managerial level of participants

Figure 5.3 shows the managerial level of participants in the focus group. The session targeted all levels of employees within the coal mining industry to ascertain different views.

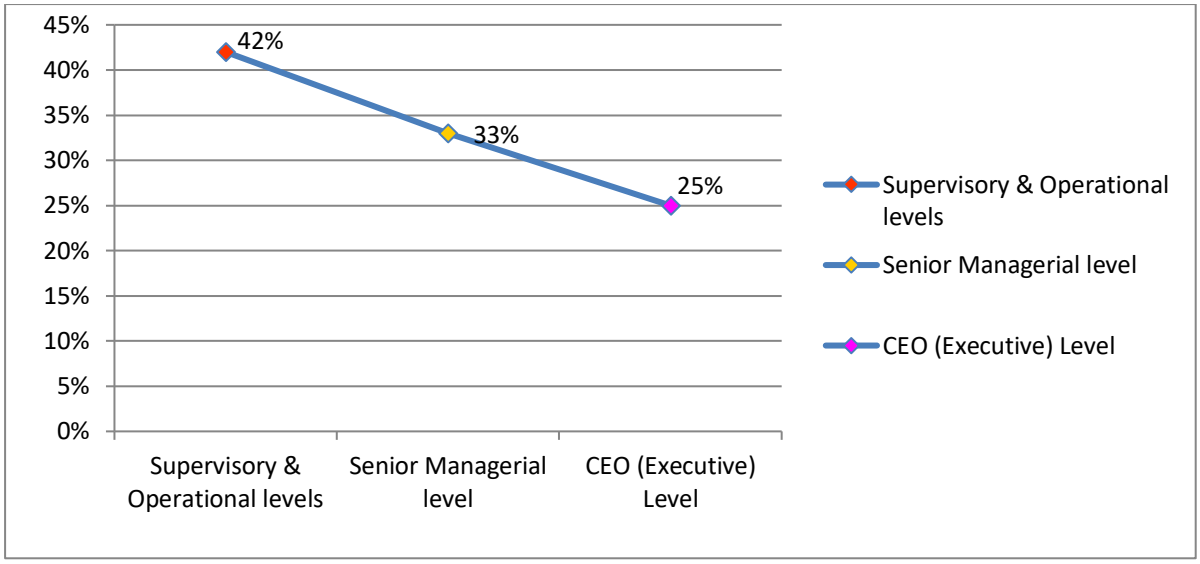

Figure 5.3: Managerial level of participants

As depicted in Figure 5.3, the majority of the respondents (42%, n=42) were at supervisory and operational levels at the time of the focus group. A significant 33% of the participants were at senior managerial levels whilst 25% of the respondents were Chief Executive Officers (CEOs) or executives. As expected, the higher the position, the fewer the respondents.

The researcher postulates that the managerial levels indicate that the participants understand and have enough expertise of the coal mining processes and procedures as they are ought to have been exposed to the coal mining core business for a substantial amount of time.

The following section provides a discussion of the findings based on the focus group validating the framework.

5.4. KEY FINDINGS FROM THE FOCUS GROUP

The following discussion is linked to the framework as presented in Figure 2.19 in Chapter 2. The relevant associations labelled by the propositions in the framework are as developed in Chapter 2. The questions indicated in the text boxes that follow are the questions posed to the focus group aimed at validating mainly the associations in the framework.

5.4.1. TOOLS (METHODOLOGIES) AND PURPOSE – (*PA4*)

Will the EMA tools (methodologies) such as ISO, MFCA, LCC and green strategy serve the purpose of reducing water pollution, lead to improved heath, improved costing in terms of savings, profit margin, and better decision-making?

Participants 6 (P6) and P1 disagreed and indicated that in *general* (all industries, not only the coal mining industry) the EMA tools (methodologies) such as ISO, MFCA, LCC and green strategy would not serve the purpose of reducing water pollution, not lead to improved heath, neither lead to improved costing in terms of savings, profit margin, and better decision-making. On probing further, it turned out the coal mining industry may well benefit from the above, as long as other industries which also compromise the environment do not come on board, the problem will prevail.

It should be noted that although the framework is customised for the coal mining industry it may well be applicable to all other industries. The researcher agrees with the argument by P1 and P6 that this framework should also apply to all other industries which may also pollute the environment.

Conclusion: From the findings of the focus group, tools (methodologies) will serve the purpose as indicated in the framework.

5.4.2. PURPOSE AND ENVIRONMENT (STAKEHOLDERS) – (*PA1*)

Do you think that the reduced water pollution, improved health, improved costing, and decision-making will benefit the investors, coal mining employees, and the natural environment?

Participants P1, P3, P6, P7, P10 and P15 all agreed that the reduced water pollution, improved health, improved costing, and decision-making would benefit the investors, coal mining employees and the natural environment. Most of the participants concurred, and P7 asked whether the researcher was satisfied with the provided answers. The researcher confirmed he was happy with the responses provided to answer the questions posed to validate the framework.

The researcher agrees with the views of the respondents and opines that internal and external stakeholders need environmental information to make informed decisions. These decisions may affect the coal mining companies in terms of their reputation and

bottom-line due to imposed penalties in cases of non-compliance to environmental regulations.

Conclusion: From the findings of the focus group, the purpose as indicated in the framework would serve the interests of the environment (stakeholders).

5.4.3. TOOLS (METHODOLOGIES) AND ENVIRONMENT (STAKEHOLDERS) – (*PA6*)

Do you think that the EMA tools such as ISO, LCC and the Green strategy will add value to the environment (stakeholders) such as investors, coal mining employees, and the natural environment?

Participants P1, P5, P6, P10, and P12 agreed that the EMA tools such as ISO, LCC, and a green strategy would add value to saving and improving the environment (stakeholders) such as investors, coal mining employees, and the natural environment by providing them with information. The rest of the participants offered no objection, hence the researcher argues that the use of an MIS (Management Information System), EMA tools such as MFCA, LCC, and a Green strategy will benefit both the internal and external stakeholders, as this will assist the coal mining companies to achieve profit and save the environment.

Conclusion: From the findings of the focus group, the tools (methodologies) as indicated in the framework and above question will add value to stakeholders and help save the environment.

5.4.4. SUBJECT FIELD AND ENVIRONMENT (STAKEHOLDERS) – (*PA2*)

Do you think that the two branches of EMA (PEMA and MEMA) will add value the environment (stakeholders) such as investors (external environment), employees (internal environment) and the natural environment in terms of providing environmental management information? For instance, in the coal mining industry, the financial accounting department or the executives and senior management might not have the environmental management information for decision-making purposes, will it add value to the coal mining industry?

Participants P2, P3, P5, and P6 agreed that the two (2) branches of EMA (PEMA and MEMA) would add value to the coal mining environment (stakeholders) such as investors (external environment), employees (internal environment), and the natural

environment in providing environmental management information. For instance, in ensuring that the financial accounting department or the executives and senior management are provided with environmental management information for them to make informed decisions in the coal mining industry. The other participants offered no objections to this viewpoint.

The researcher maintains that the flow of financial management information is critical to the success of coal mining companies. Decisions should be based on both the physical (PEMA) and monetary information (MEMA). Therefore, the environmental management teams should work together in sharing information with the financial accounting teams. Moreover, senior management such as the executives and stakeholders should be provided with timely information as to how the coal mining companies are performing financially as well as how they are impacting the environment.

Conclusion: From the findings of the focus group, the subject field indicators in the framework will have a positive influence on stakeholders and the environment.

5.4.5. SUBJECT FIELD AND TOOLS (METHODOLOGIES) – (*PA3*)

Do you think that the two branches of EMA (PEMA and MEMA) will add value to the EMA tools such as ISO, LCC, and the green strategy?

Participants P2, P3, and P14 agreed that the two (2) branches of EMA (PEMA and MEMA) would add value to the EMA tools such as ISO, LCC, and a green strategy. No objections were posed by any of the other participants. Consequently, the researcher concludes that the two (2) EMA branches are critical. Moreover, the two (2) branches are of significance in providing the physical flows of materials and associated costs as this directly affects the coal mining companies due to financial implications.

Conclusion: From the findings of the focus group, the subject field indicators in the framework will provide valuable information to be used by the tools and methodologies involved.

5.4.6. REGULATORY AND PURPOSE – (*PA7*)

Do you think that the flow of regulatory information (such as ISO, GRI, and King IV) would assist to reduce water pollution, reduce environmental impacts, improve costing, and enhance better decision-making?

Participant P7 agreed that the flow of regulatory information (such as ISO, GRI, and King IV) would assist to reduce water pollution, reduce environmental impacts, improve costing, and enhance decision-making. However, P6 was hesitant in the sense that the regulatory information would certainly be applicable to the coal mining industry, but regulatory initiatives would remain challenged if other industries continue to pollute and compromise the environment, as these industries are not equally strictly regulated and monitored.

The following argument has been presented by the group: the coal mining industry is well regulated and spends funds in addressing environmental damages, yet it seems to be the only industry that is being penalised for environmental pollution. Although it is a good initiative to spend money for environmental purposes, the municipalities are not penalised for polluting the environment, hence there is inconsistency in the application of regulations. Therefore, you cannot spend money in one area and expect that it will address environmental pollution in other areas and sectors. For instance, there is a municipality sewage plant and water from this plant (at Emalahleni) that is polluted and flows into the farms and coal mining area, and nothing is being done to prevent it by the law enforcement agencies. It seems, therefore, as if the focus is on penalising the coal mining industry whilst other industries do as they wish. There is inconsistency in the application and enforcement of regulatory legislation as per the focus group.

The researcher concurs with the concern raised by the participants in that regulations should be fairly applied or enforced across all industries, not subjectively to only the coal mining industry. Coal mining companies ought not to be penalised based on guidelines. Such regulations were not specifically designed for the coal mining industry but for all industries in South Africa.

Conclusion: From the findings of the focus group, it is clear that regulatory guidelines ought to serve the purpose of the coal mining industry in feeding regulatory information into the purpose statement(s) of the industry.

5.4.7. REGULATORY AND ENVIRONMENT – (*PA5*)

Do you think that regulatory guidelines will benefit the investors, the coal mining employees, and the environment?

Participant P7 stated that the sensible application of regulatory guidelines would benefit the environment but not necessarily the investors. However, P3 argued there should be a provision for the decision-making framework and the regulations to be applicable to all industries or sectors and not only the coal mining industry as intended by this research. Participant P10 indicated that in principle, guidelines are fine, however, the South African government has developed a habit of turning guidelines into law and coal mines are penalised for transgressions of the guidelines, which is not correct as guidelines are supposed to advise and guide coal mining companies to conduct their business in the correct manner. Therefore, guidelines should not be interpreted as hard-and-fast laws. There was general consensus in the group about these aspects.

The researcher contends that the South African government should separate guidelines from regulations and refrain from enforcing guidelines as laws. However, government ought to guide the coal mining industry to do the right thing; for instance, to understand and adopt regulatory principles to save the environment.

Conclusion: From the discussions amongst group members there was a general consensus that regulatory aspects can go a long way in controlling adverse effects on the environment, so long as these would be applied to all industries, and not only the coal mining industry.

5.4.8. REGULATORY AND RISK ASPECTS – (*PA8*)

Will the regulations and policies assist in the identification of risk and mitigation in the coal mining industry? What is your view?

Participant P6 agreed that the regulations and policies would assist in the identification of risk and mitigation in the coal mining industry. However, regulations should be consistently enforced to all industries in South Africa and not only to the coal mining industry, as is currently the case (opinion of the group). P6 also indicated that the coal mining industry is being strictly monitored and audited yet invests large

amounts of money on environmental aspects and these benefits are readily evident, hence should be applied to all industries.

The researcher infers that regulations such as the GRI guidelines, ISO, King IV, NEMA, Health regulations, and other relevant government legislation should serve to identify any possible environmental management risks and mitigation thereof. If coal mining companies are not able to detect any risks, then their risk management plans are not effective.

Conclusion: From the discussions it emerged that regulations may go a long way in assisting the coal mining industry in identifying, mitigating or even avoiding risks altogether in their day-to-day operations.

5.5. DISCUSSION

On the matter of the association between tools (methodologies) and purpose it was evident that the uncertainty raised by participant P6 about the EMA tools (methodologies) such as ISO, MFCA, LCC, and green strategy not serving the purpose of reducing water pollution, not leading to improved heath, not leading to improved costing in terms of savings, profit margin, nor better decision-making, was actually a call to apply the research to all industries, and not only to coal mining. Hence, the concern was that the decision-making framework is designed to provide information to the coal mining companies but disregards other industries. The claim was made that addressing environmental impacts in a single industry would not be enough; all relevant industries need to be considered.

On aspects regarding associations between purpose and environment (stakeholders), tools (methodologies) and environment (stakeholders), and subject field and environment (stakeholders), the group members agreed on these respective associations.

On the issue of whether the flow of regulatory information (such as ISO, MFCA, LCC, and Green strategy) would assist in reducing water pollution, reduce environmental impacts, improve costing and enhance better decision-making, the participants raised concerns that there is inconsistency in the application and enforcement of regulations – coal mining appears to be the only industry that is strictly monitored

and penalised for environmental transgressions whilst other industries *do as they wish*, hence the group viewed this as an unfair practice.

On the matter of whether regulatory guidelines would benefit the investors, the coal mining employees, and the environment, there was a sentiment that the regulatory guidelines would benefit the environment and not the investors. This sentiment stems from a view that environmental regulations are meant to protect the environment and not the investors. In most instances, investors are interested in the bottom line and not the environmental impacts. A concern was also raised that the South African government has a tendency of turning environmental guidelines into laws, often punitive in nature instead of being advisory in nature.

On the matter of whether regulations and policies would assist in the identification and mitigation of risk in the coal mining industry, the findings indicated that regulations and policies should be applicable to all industries and not to just one particular sector.

5.6. A DECISION-MAKING FRAMEWORK FOR SOUTH AFRICAN COAL MINING COMPANIES (ENHANCED)

Following the findings from the qualitative interviews in Chapter 4 and the above focus group findings, the final decision-making framework is given in Figure 5.4. The risk entity was identified in Chapter 2, its components emerged from the interviews in Chapter 4, and its association was determined following the focus group discussions.

The unbroken arrows indicate the flow of information whilst the dashed arrows indicate control between the entities. To avoid unnecessary clutter, it was decided to remove the denotations of the propositions inside the entities (that is content- and general propositions) yet keep the association propositions as indicated in the framework.

The final decision-making framework appears in Figure 5.4.

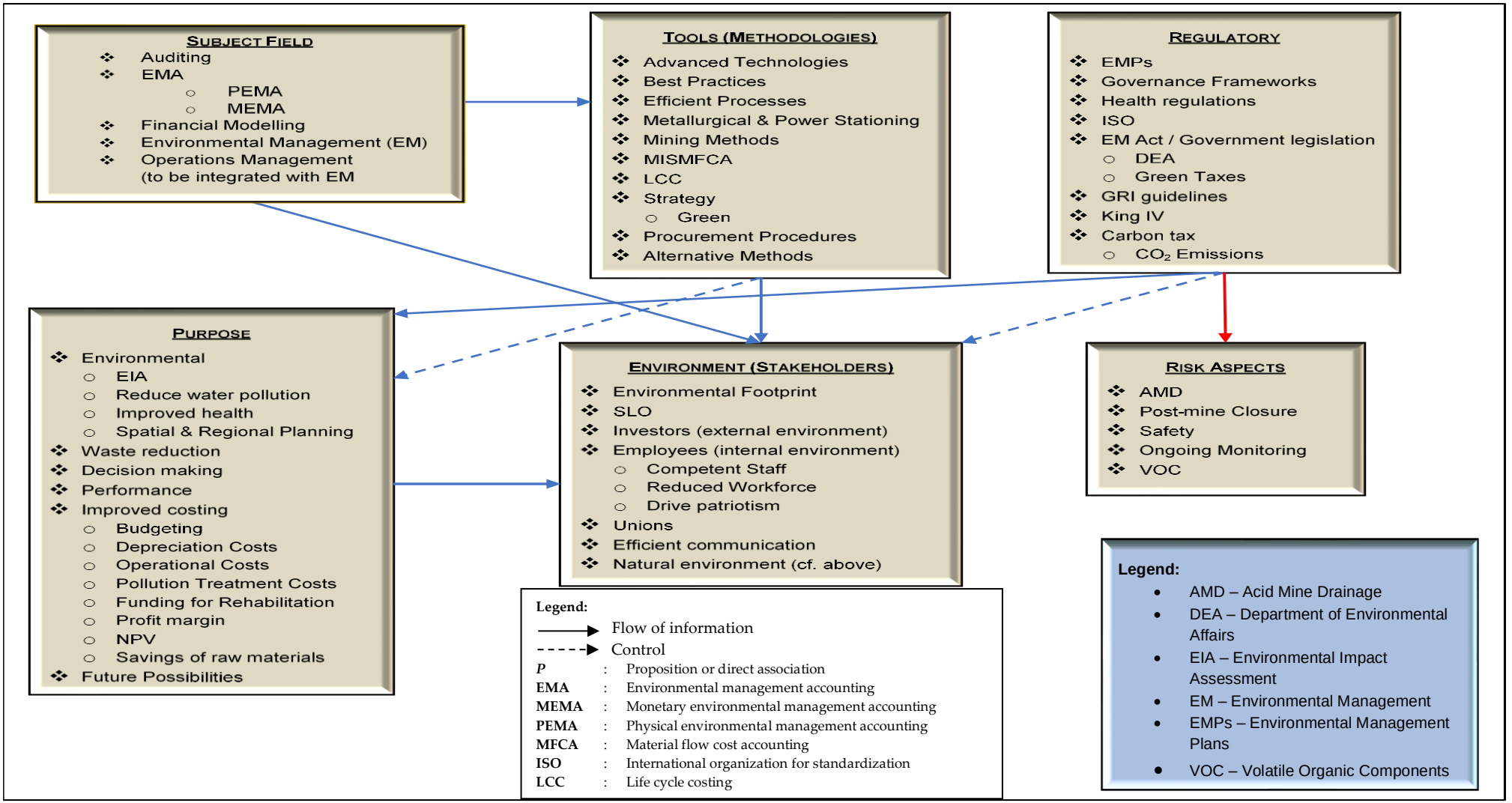

Figure 5.4: The enhanced decision-making framework for South African coal mining companies (*Source: Constructed by researcher)*

5.7. SUMMARY

In this chapter, the validation of mainly the associations identified in the preliminary framework depicted in Figure 2.19 in Chapter 2 was confirmed through a focus group consisting of twelve members. All associations previously identified were confirmed and an association between Risk Aspects and Regulatory aspects was established. A final decision-making framework as depicted in Figure 5.4 was presented.

The following chapter which is the conclusions, recommendations and future work presents, amongst others, a comparison of the findings from the personal interviews in Chapter 4 and the focus groups session in the current chapter.

CHAPTER 6 – DISCUSSION, CONSLUSION AND RECOMMENDATIONS

6.1. INTRODUCTION

The preceding chapter provided the findings of the research and further informed the focus group in order to test the associations and links among the entities in the decision-making framework. Moreover, Chapter 5 also presented the final framework that was developed in Chapter 2 and enhanced through the findings of the interviews in Chapter 4 and association validations of the focus group.

The current chapter discusses the research findings, consolidates the findings of the personal interviews and focus group, and provides conclusions as well as recommendations. Directions for further research in this area are also unpacked.

6.1.1. Goal of Chapter 6

The goal of this chapter is to discuss the findings and to make recommendations as well as conclusions of the study. This discussion is based on the findings of the face-to-face interviews and focus group. This chapter also demonstrates how the research objectives of this study were achieved and plots directions for future research in this area.

6.1.2. Layout of Chapter 6

The layout of Chapter 6 is as follows: following the above introduction and goal of the chapter, Section 6.2 presents a brief review of the study, followed by a discussion of the findings, and a consolidation of the findings of the interviews and the focus group in Sections 6.3 and 6.4 respectively. Table 6.1 elaborates further on these surveys on the strength of the objectives set for the research. Contributions, a general conclusion, and recommendations follow in Sections 6.5, 6.6 and 6.7 respectively. The chapter concludes with some directions for future research in Section 6.8.

6.2. BRIEF REVIEW OF THE STUDY

This study was conducted across all coal mining companies in South Africa, and the following highlights some of the key findings of the research.

- Chapter 1 demonstrated that coal deposits in South Africa are located in Kwa-Zulu Natal Province, Emalahleni (Mpumalanga Province), and Lephalale (Limpopo Province). However, coal mining in Kwa-Zulu Natal was decommissioned, thereby leaving active mines in areas such as Emalahleni in Mpumalanga Province and Lephalale (McCarthy & Pretorius, 2009:65; Bordy, Hancox & Rubidge, 2004:392).
- Consequently, the coal mining companies were representative of the coal mining industry sector. Therefore, participants were representative of all major coal mining companies in South Africa for both personal interviews and focus group.
- In addressing the research objectives of this study, a qualitative research design was adopted that started with a comprehensive literature review, culminating in a preliminary framework as depicted in Figure 2.19.
- The researcher received ethical clearance from UNISA's Ethics Committee. Leedy & Ormrod (2015:1200) as well as Wagner *et al*. (2012:89) advised that when people or humans are involved in a study, researchers should consider ethical implications based on what they are intending to do.
- Following the literature review, face-to-face interviews were conducted to collect primary data and subsequently enhance the content of the entities in the preliminary framework.
- A focus group aimed at validating the associations among the entities was conducted.
- Creswell's data analysis spiral process was utilised to analyse data (Creswell, 2007:151)
- The preliminary framework was enhanced based on the input gathered from the interviews, and the associations were validated by the focus group session, culminating in the final framework in Figure 5.4 at the end of Chapter 5.

6.3. DISCUSSION

The general sentiment is that most participants raised similar views in their responses. There are a few who disagreed and some who were not aware of EMA as a subject matter, hence these will be discussed:

- From the gender issue, more males (67%) were interviewed than females (33%) and this could be attributed to the disparity or biasness in employment equity wherein coal mining companies may still prefer to employ men over women due to the nature of the mining activities. The researcher is of the view that the fact that more males participated in the interview process does not impair the findings of the study as both genders are exposed to the same mining functions and their experiences are similar.
- On the matter of years of work experience, most participants (both male and female) had work experience of 0-15 years (60%), 7% had 21-30 years of working experience, and 20% had 16-20 years of working experience whilst 13% had working experience ranging from 31-40 years in the coal mining industry. The researcher opines that the personal interview process targeted participants with a wide depth of knowledge and understanding of the coal mining processes and procedures (up to years of work experience.) This implies that these participants had ample experience and knowledge. Therefore, participants were in a position to respond to all the posed questions.
- Regarding the issue of managerial level, most participants were either at supervisory/operational level or at a senior management level. The researcher is of the view that these participants had sufficient exposure to both operational as well as managerial experience, which is the coal mining's core business. However, 23% of the participants were at an executive level meaning that the study also intended to sample respondents from this level to understand their views through the interview process.
- Regarding the matter of determining the information that the coal mining industry is using to make decisions with regard to the impact on the environment, most participants raised similar views on the use of Environmental Impacts Assessments (EIAs), Environmental Management Plans (EMPs), advice from coal mining consultants and the NEM (National Environmental Management) Act 107 of 1998. The researcher is of the view that coal mining companies are on the correct tract as these are recommended policies and procedures as well as legislation as prescribed by the relevant departments. This was also confirmed by Prno and Slocombe (2014) who opined that coal mining companies should engage local communities in which they operate and

to be held accountable for their environmental consequences thereby promoting environmental accountability.

- On the issue of establishing the information needed by the coal mining industry to identify waste, some participants were not sure nor specific in terms of what information is needed to identify waste. The researcher postulates that coal mining companies might be disposing of waste without considering the impact on the environment. However, the majority of the participants alluded to the National Environmental Management: Waste Act, 59 of 2008, which defines the types of waste and mitigation thereof, input from the technical or survey departments, chemical waste and analyses or source pathway receptors and waste samples, and process information. Researchers such as Qian *et al.* (2011:93), Kirsch (2010:88) and Gavriletea (2017:19) confirmed this.

  The researcher opines that most coal mining companies seem to have the relevant information required for identifying waste but is concerned about those coal mining companies who are in doubt of what information is required to identify waste hence this is a risk to local communities and the environment.

- The matter of defining the information to be used by the coal mining industry to reduce costs regarding their impact on the environment: most participants indicated that coal mining companies utilise project designs, planning, and budget of environmental impacts, legal requirements as ascertained by legislation, options of recycling waste, reusing, and generating zero waste such as dry cooling beneficiation, proper planning, and discharge of effluent. Other respondents further indicated the use of spatial data, improved benchmark data, and accurate quantification of the environmental impact, material flow cost accounting (MFCA) as well as best practice guidelines such as GRI guidelines. Researchers such as Fakoya & van der Poll (2013:136), IFAC (2005:19) as well as Nakajima and Kimura (2013:1) confirmed this.

  The researcher postulates that coal mining companies have ample tools that can be employed to reduce costs regarding the impact on the environment. However, there is little or no measure of consistency as to whether most of the coal mining companies are applying or utilising this information or not. This was also evident when a few respondents suggested that coal mining companies should be proactive instead of being reactive in addressing environmental

impacts. The researcher is of the view that by being proactive, coal mining companies will be able to reduce and minimise environmental costs (or hidden costs) to measure the extent to which their mining operations are impacting the environment).

- Regarding the matter of establishing the efficiency of existing processes employed by the coal mining industry to facilitate decisions in terms of their environmental impacts, most of the participants did not say much regarding the efficacy of existing processes that are being utilised by the coal mining companies since they did not have facts or figures. However, a few respondents mentioned that the integration of environmental management with operational management and water management remain a challenge. Reviewed literature confirmed the preceding discussion as opined by Jasra *et al.* (2011:278).

  The researcher suggests that it is a challenge that most participants who occupy senior managerial, operational, supervisory, and executive levels are not aware of which methodologies could be applied to mitigate environmental impacts. Therefore, the researcher contends that there is an environmental knowledge gap and a need to address this gap within the coal mining industry.

- The issue of establishing the efficiency of existing processes employed by the coal mining industry are to facilitate decisions in terms of elated cost-savings; most respondents alluded to water saving strategies and the need to have dedicated budgets assigned to environmental issues. However, the researcher is of the view that it is a concern as most participants suggested that coal mining companies need to reduce their environmental footprint and also that most respondents maintained that current processes employed by the coal mining industry are not effective as cost saving strategies and are centred on production costs but not on reducing environmental impacts. Therefore, this places a risk on the environment.
- On the matter of determining familiarity with EMA, the researcher contends that it is a challenge that a higher percentage of those who were interviewed (73%) indicated that they are not familiar with EMA, while only 27% indicated that they are familiar with EMA. Reviewed literature confirmed the assertion that most coal mining personnel who are entrusted in implementing EMA are not aware or well vested with the subject matter. Moreover, to use MFCA or LCC as a tool

to capture data and to make informed decisions (Saeidi & Sofian, 2014:30; Bracci & Maran, 2013:541; Fakoya & van der Poll, 2013:136).

The researcher opines that the high number of participants who are not familiar with EMA shows a gap in EMA knowledge, skills, and the adoption of EMA in the coal mining industry.

- On the matter of determining the benefits of EMA for the coal mining industry, the researcher infers that the coal mining industry should understand the benefits and detriments of economic development and environmental impacts. This will enable coal mining companies to make informed decisions in preserving the environment from pollution, improve LCC, allow for cost benefit analysis, and optimise environmental spending to prevent exceeding the budget.
- Regarding the issue of determining the reasons for possible non-implementation of EMA principles and tools by the coal mining industry, most participants alluded to the fact that the adoption and implementation of EMA is not a legal requirement but voluntary. They argued that coal mining companies are focussed on profits other than assigning financial resources to environmental issues, insufficient funds for rehabilitation as well as related liabilities, lack of awareness and understanding of EMA, lack of projecting and categorising overheads, lack of environmental strategies, and challenges associated with implementing EMA. Researchers such as Jasch (2006:1195), Kamruzzaman (2012:2) and EPA (1995:7) echoed this.

  The researcher purports that the fact that EMA is not a legal requirement but voluntary in nature in SA, coal mining companies may not feel obligated to adopt EMA principles and procedures. Therefore, coal mining companies will see little or no reason to come up with environmental strategies to find a need or purpose to understand EMA from a corporate level down to operational levels.

- Determining the processes that ought to be followed by the coal mining industry to make decisions in terms of their environmental impacts: most participants indicated that they are aware of what processes and procedures should be followed by the coal mining industry in making decisions in terms of their

environmental impacts. They also demonstrated their knowledge relating to the environment and legislation such as the NEMA Act including policies or guidelines, for instance, the EIAs and the EMPs or DEA processes. The National Treasury, South Africa (2017:9), Kim (2002:62), as well as Schaltegger *et al*. (2000:18) confirmed this in the reviewed literature.

The researcher postulates that although there are ample processes and environmental policies including applicable legislation such as the NEMA Act and EIAs, participants did not indicate how coal mining companies are being monitored to determine their level of compliance to these policies and legislation. A company may have the best policies and strategic plans, but implementation is a different subject altogether.

- Determining the processes that ought to be followed by the coal mining industry to make decisions in terms of their related costs: most participants demonstrated their awareness of modern tools and stakeholder engagement, the appointment of competent environmental staff, and provisions required for post-mine closure activities. Proper procurement procedures and processes include financial modelling of projects, moving away from tick-box exercises, full-cost accounting, the use of technology to assess long-term cost impacts and cost savings, and cost benefit analysis of alternative methods.

  The researcher agrees with the view raised by Holt (2009:5) in that coal mining companies may lower production costs and achieve savings if they factor in environmental costs in their budgets and by calculating cost implications (hidden costs.) However, knowledge of what processes and procedures that ought to be followed in terms of related costs by the coal mining companies does not guarantee the effective application within the mining industry.

The following section demonstrates how the research objectives of this study were achieved in terms of the interviews in Chapter 4 and the focus group in Chapter 5, having followed on the preliminary framework construction in Chapter 2.

6.4. CONSOLIDATION OF THE FINDINGS BASED ON THE PERSONAL INTERVIEWS AND FOCUS GROUP SESSION

Table 6.1 demonstrates how the research objectives of this study were achieved in terms of the qualitative interviews and the focus group.

Table 6.1: Consolidation of findings based on the personal interviews and focus group session

DEMONSTRATION OF HOW RESEARCH OBJECTIVES WERE ADRESSED I.T.O. INTERVIEWS AND FOCUS GROUP				
NO	**RESEARCH OBJECTIVE**	**PERSONAL INTERVIEWS**	**FOCUS GROUP**	**ANALYSIS**
1	**Research objective 1:** Determine the information that the coal mining industry is using to make decisions with regard to the impact on the environment.	• Personal interviews established that the coal mining industry is utilising information such as; - Environmental Impacts Assessments (EIAs) - Environmental Management Plans (EMPs) - advice from coal mining consultants - the NEMA Act 107 of 1998 to make decisions regarding impact on the environment. • Personal interviews also demonstrated that the two branches of EMA (PEMA and MEMA) will add value in saving the environment and enable coal mining companies to achieve profit.	The focus group did not indicate information such as EIAs, EMPs, advice from coal mining consultants and the NEMA Act 107 of 1998 as was the case with face-to-face interviews but confirmed the associations among the entities containing these attributes, namely associations between the Subject field and the Environment (Stakeholders).	It can be established that the coal mining industry is aware of what information is required to make decision regarding the environment. However, the researcher argues that being aware of such information does not guarantee consistent adoption and implementation of EMA. In the same context, sentiments from the focus group confirmed that the two branches of EMA (PEMA and MEMA) are applicable and relevant in the coal mining industry for decision-making purposes, confirming the subject field – environment (stakeholder) link.
2	**Research objective 2:** Establish the information needed by the coal mining industry to identify waste.	• Personal interviews established that information needed by the coal mining industry to identify waste include: - the National Environmental Management: Waste Act, 59 of 2008, which defines the types of waste and mitigation thereof. - input from the technical or survey departments.	The focus group confirmed that the information required by the coal mining industry is relevant and applicable for decision-making within the coal mining industry, thereby confirming the association between Regulatory and Purpose in the framework.	It can be concluded that there is consensus between personal interviews and the focus group on the type of information needed by coal mining industry to identify waste and for decision-making purposes and regulations regarding these.

DEMONSTRATION OF HOW RESEARCH OBJECTIVES WERE ADRESSED I.T.O. INTERVIEWS AND FOCUS GROUP				
NO	**RESEARCH OBJECTIVE**	**PERSONAL INTERVIEWS**	**FOCUS GROUP**	**ANALYSIS**
		- chemical waste and analyses or source pathway receptors and waste samples and process information. • EMA tools such as ISO, LCC and green strategy were considered as information needed by the coal mining industry to identify waste.		
3	**Research objective 3:** Define the information to be used by the coal mining industry to reduce cost with regard to their impact on the environment	• Personal interviews established that coal mining companies utilise: - project designs - planning and budget of environmental impacts - legal requirements as ascertained by legislation - options of recycling waste, reusing and generating zero waste such as dry cooling beneficiation - proper planning and discharge of effluent - use of spatial data, improved benchmark data and accurate quantification the environmental impacts - material flow cost accounting (MFCA) - best practice guidelines such as GRI guidelines to reduce costs.	• The focus group session confirmed key themes that were eminent in the face-to-face interviews and established that EMA tools (methodologies) such as ISO, MFCA, LCC and green strategy serve the purpose of reducing water pollution, lead to improved costing in terms of savings, profit margin and better decision-making, hence the association between Tools (methodologies) and Purpose. • As a secondary observation, the focus group also highlighted that environmental impacts should be addressed in all industry sectors, and not only the coal mining industry.	It can be established that personal interviews and the focus group agreed on the information and tools to be used by the coal mining industry to reduce cost regarding their impact on the environment, cf. the link indicated on the left. However, environmental impacts should be addressed across all industries, indicating that the coal mining industry believe they are being singled out with respect to environmental aspects.

DEMONSTRATION OF HOW RESEARCH OBJECTIVES WERE ADRESSED I.T.O. INTERVIEWS AND FOCUS GROUP				
NO	**RESEARCH OBJECTIVE**	**PERSONAL INTERVIEWS**	**FOCUS GROUP**	**ANALYSIS**
4	**Research objective 4:** Establish how effective existing processes employed by the coal mining industry are to facilitate decisions in terms of environmental impacts and related costs	• Personal interviews established that existing processes employed by the coal mining industry are to facilitate decisions in terms of environmental impacts and related costs were effective in terms of water saving strategies. • Personal interviews established that there are no dedicated funds allocated for environmental issues. • Moreover, coal mining companies needed to reduce their environmental footprint as current processes employed by the coal mining industry are not effective as cost savings are centred on production costs but not on reducing environmental impacts.	• The focus group established that reduced water pollution, improved health, improved costing and decision-making would benefit the investors, coal mining employees and the natural environment (as alluded to by participants P1, P3, P5, P6, P7, and P10, and P15), cf. an association between Purpose and Environment (Stakeholders). • However, the focus group session did not directly answer the question as to how effective existing processes employed by the coal mining industry are to facilitate decisions in terms of environmental impacts and related costs.	It can be concluded that coal mining companies needed to reduce their environmental footprint. Furthermore, current processes employed by the coal mining industry are not effective as they are focussed on generating revenue instead of minimising environmental impacts.
5	**Research objective 5:** Determine familiarity with EMA	• Personal interviews demonstrated that most participants (73%) in the coal mining industry are not familiar with EMA.	• The focus group did not test familiarity with EMA but validated that EMA principles such as LCC and MFCA could be used to save the environment and enable coal mining companies to achieve operational efficiency, i.e. the	It can be ascertained that most participants in the coal mining industry are not familiar with EMA implying that coal mining activities may be detrimental to the environment and local communities.

DEMONSTRATION OF HOW RESEARCH OBJECTIVES WERE ADRESSED I.T.O. INTERVIEWS AND FOCUS GROUP				
NO	**RESEARCH OBJECTIVE**	**PERSONAL INTERVIEWS**	**FOCUS GROUP**	**ANALYSIS**
			association between Subject filed and Environment (Stakeholders).	
6	**Research objective 6:** Determine benefits of EMA for the coal mining industry	• Personal interviews established that better understanding of the trade-offs between economic development and the environmental impacts; better decision-making, protection of the environment from pollution, enabling coal mining companies to minimise waste and improves life cycle costing; • EMA provides for cost benefit analysis, optimises environmental spending to prevent exceeding budget, production and environmental management work in harmony; • EMA enables the coal mining industry to identify resources, activities and impacts of mining operations and the related financial implications thereof.	• The focus group demonstrated that the two branches of EMA (PEMA and MEMA) makes provision for the coal mining industry to identify resources, activities and impacts of mining operations and the related financial impacts thereof. EMA tools such as LCC and MFCA quantifies resources, allocates costs and identifies waste and associated costs thereof – cf. association between Subject field and Tools (Methodologies).	It can be established that EMA allows the coal mining industry to identify resources, activities and impacts of mining operations and the related financial impacts thereof; it helps coal mining companies to be proactive in environmental management issues through the application of EMA tools such as MFCA and LCC.
7	**Research objective 7:** Determine the reasons for possible non-implementation of EMA principles and tools by the coal mining industry	• Personal interviews established that: - the adoption and implementation of EMA is not a legal requirement but voluntary in nature; - coal mining companies are focussed on profits than allocating dedicated budgets for environmental issues; - there is lack of awareness and understanding of EMA;	• The focus group did not determine the reasons for possible non-implementation of EMA principles and tools by the coal mining industry but tested the links and associations of the decision-making framework.	It can be ascertained that EMA is not a legal requirement but voluntary. However, awareness should be created so that the coal mining industry may understand EMA, be able to project and categorise their environmental impacts and related costs.

DEMONSTRATION OF HOW RESEARCH OBJECTIVES WERE ADRESSED I.T.O. INTERVIEWS AND FOCUS GROUP				
NO	**RESEARCH OBJECTIVE**	**PERSONAL INTERVIEWS**	**FOCUS GROUP**	**ANALYSIS**
		- there is a lack of environmental strategies and challenges associated with implementing EMA.		
8	**Research objective 8:** Determine the processes that ought to be followed by the coal mining industry to make decisions in terms of environmental impacts and related costs	• Personal interviews ascertained processes that ought to be followed by the coal mining industry to make decisions in terms of environmental impacts such as: - The appointment of environmental management staff - proper procurement procedures and processes including financial modelling of projects - moving away from tick-box processes / exercises. - full-cost accounting; the use of technology to assess long-term cost impacts and cost savings - the identification of risks, environmental hazards and impact analysis - existing legislative instruments that need to be enforced and adhered to such as EIAs and EMPs, NEMA Act; - proper consultation with environmental personnel in decision-making processes - consultation with government departments, research- and academic institutions.	• The focus group identified EMA tools such as PEMA and MEMA namely MFCA, LCC and the green strategy as tools that would enable to provide information that would identify environmental impacts as well as related costs, c.f. the association between Tools (Methodologies) and Environment (Stakeholders) as well as Purpose.	It can be established that the coal mining industry is aware of the processes that need be followed to make decisions in terms of environmental impacts and related costs.

Source: *Synthesised by Researcher*

6.5. CONTRIBUTION OF THE STUDY TO THEORY AND PRACTICE

From a theoretical perspective, a peer reviewed article was published in 2018 in the *Sustainability* Journal (Annexure G), based in Switzerland, thereby adding value to the body of knowledge. The preliminary framework presented in the article emanated from the literature review in Chapter 2.

This study also serves as a benchmark for future studies from a South African perspective as well as globally. From a practical point of view (policy perspective), this study provides insight for the South African government to review environmental policies and to determine efficiencies thereof. The study identified a gap in knowledge in that there is a need for the coal mining industry in South Africa to be educated on EMA as a concept. The researcher postulates that the decision-making framework developed in this study will assist coal mining companies as well as other industry sectors to identify waste, review their operational activities, and strive to capitalise their profit margins whilst saving the environment.

6.6. GENERAL CONCLUSION

This study intended to develop a decision-making framework to facilitate cost savings and mitigate environmental impacts on the coal mining industry in South Africa. Moreover, it investigated why coal mining companies are not employing EMA principles. This led to the establishment of a framework to assist coal mining companies in South Africa to apply appropriate and relevant EMA principles to preserve the environment and its natural capital. The developed environmental management framework (EMAF) was presented at the end of Chapter 2. Personal interviews were conducted to address the research objectives of this study, aimed at validating and further enhancing the content of the entities. A focus group was also conducted to validate the associations between the entities and further consider the entities in the framework.

The findings of this study noticed that more males than females participated in the research. However, we argue this does not affect the outcome of the findings of the study as both genders are exposed to the same mining functions and conditions, therefore, their experiences ought to be similar. The fact that respondents had working experience ranging up to 40 years means that participants were knowledgeable and

understood the coal mining core business. Fifteen (15) participants were interviewed during the face-to-face interviews, whilst 12 participants from seven (7) coal mining companies formed part of the focus group.

The study ascertained that the coal mining industry is currently utilising information such as EIAs, EMPs, advice from coal mining consultants, and the NEMA Act 107 of 1998 in making decisions about the impact on the environment. However, some participants were unsure and not specific in terms of what information is needed to identify waste in the coal mining industry.

The research further established that existing processes employed by the coal mining industry are not efficient, and most personnel in the coal mining industry are not familiar with EMA as a concept. Consequently, the study established that most coal mining companies did not adopt and implement EMA as it is not as legal requirement. The study ascertained that there are suitable processes and environmental policies as processes that ought to be followed by the coal mining industry to make decisions in terms of their environmental impacts and related costs.

6.7. RECOMMENDATIONS

A number of recommendations emanated from the literature review, interviews, and the focus group.

The interviews achieved much in enhancing the attributes of the entities in the framework. The outcome of this process is depicted in Section 4.6 in Chapter 4.

In validating the associations in the framework, the researcher provided each focus-group participant with a hard copy of the rudimentary framework (Figure 2.19) and used an overhead projector to present the decision-making framework. While the purpose of the focus group was primarily to validate the associations, they also commented briefly on the content of some of the entities. These findings, in conjunction with the interviews, are briefly mentioned in Table 6.1.

The recommendations for the coal mining industry emanating from the research follow next.

- Coal mining companies should incorporate environmental accountability in their corporate strategy (vision and mission statements), As well as assess cost implications and focus on environmental interventions to avoid unnecessary

costs to remedy any possible environmental damage in future (prevention is better than cure.)

- Coal mining companies should develop environmental policies aligned to their corporate strategies and integrate these into the KPIs of their employees and management for implementation and evaluation as well as performance management system.
- On the matter of determining the information that the coal mining industry is using to make decisions with regard to the impact on the environment, it is recommended that the South African government should ensure that coal mining companies understand the impact of their decisions or activities with regard to the environment.
- Research should be regularly conducted to determine challenges facing the coal mining industry and its impact on the environment. For instance, the extent of underground fires in South Africa and implication thereof should be considered.
- On the issue of establishing the information needed by the coal mining industry to identify waste, it is recommended that education and training should be conducted in all coal mining companies in order for these companies to know and understand the type of information that they need to utilise in identifying waste.
- The matter of defining the information to be used by the coal mining industry to reduce costs regarding their impact on the environment: it is recommended that coal mining companies must be proactive in assessing the extent to which their mining operations are affecting the environment. This should be reflected in their environmental reports on a quarterly and annual basis.
- The coal mining industry should strive to reduce its environmental footprint and minimise environmental costs (or hidden costs) by going green through initiatives such as reuse and recycling.
- Coal mining companies should change their attitude from focussing on just profits (bottom-line) to considering the impact of their mining activities on the environment.
- On the issue of establishing the efficiency of existing processes employed by the coal mining industry to facilitate decisions in terms of their environmental

impacts: it is recommended that environmental audits ought to be conducted to identify environmental knowledge gaps, determine the efficiency of activities each coal mining company and initiate relevant mitigation.

- Regarding the matter of determining familiarity with EMA, it is recommended that the South African government (through both national and local government) should promote the adoption and implementation of EMA by engaging the stakeholders in the coal mining industry.
- Coal mining companies should engage local communities in which they operate and should be able to answer for their environmental activities thereby promoting environmental accountability. Coal mining companies could be achieved by forming partnerships with local communities.
- The issue of determining the reasons for possible non-implementation of EMA principles: it is recommended that coal mining companies should have dedicated environmental management budgets.
- The matter of determining the processes that ought to be followed by the coal mining industry to make decisions in terms of their environmental impacts: it is recommended that monitoring and evaluation must be conducted on a regular basis. This will help to determine the level of compliance in line with the processes that ought to be followed by companies considering the environmental impacts.
- The matter of determining the processes that ought to be followed by the coal mining industry to make decisions in terms of their related costs, it is recommended that coal mining companies should incorporate their environmental costs in their annual budgets and to reflect these in their quarterly and annual financial statements.
- There should be effective communication between operational management and the accounting function as alluded to in Chapter 2. These departments should work together in such a way that decision-makers (Executives) are equipped with accounting as well as environmental information to make informed decisions.
- On the matter of the link between tools and purpose as per the decision-making framework: it is recommended that the decision-making framework must be applied to all industry sectors. Addressing environmental impacts in a single

industry is not enough. Hence, there is a need to provide information to all industries and relevant stakeholders.

- On the matter of whether regulatory guidelines would benefit the investors: it is recommended that environmental awareness must be conducted to investors so that they can make a provision for environmental budgets.
- On the matter of whether regulations and policies would assist in the identification of risk and mitigation in the coal mining industry: it is recommended that awareness should be created so that coal mining companies can implement the decision-making framework to quantify their environmental impacts so that they can also achieve savings.

6.8. SELF-REFLECTION

The following section indicates the challenges encountered by the researcher as well as mitigation thereof.

Table 6.2: Challenges experienced by the researcher and mitigation

Challenges encountered	Mitigation
Difficulty in getting access to coal mining companies	The researcher attended the coal mining colloquium that was organised by Coaltech (an organisation managing coal mining companies). The researcher was able to network and get contacts.
Permission letters for interviews: Most coal mining companies work on production hence they preferred the researcher to engage them once instead of twice (during request for permission letters and personal interviews).	The researcher explained to the participants the significance of the ethics application in comparison with initial personal interviews.
Balancing family time with conducting research	This was challenging and demanding. However, the researcher conducted most research from home with the aid of 3G. Moreover, the researcher printed most of the articles during the day and read these later at home. In some instances, the researcher took family out to outlets, which offer wireless networks and was able to conduct research whilst children were

Challenges encountered	Mitigation
	playing games. The researcher had maximum support of his wife.
Balancing work with research	The researcher performed work-related activities in advance and uploaded on the shared drive. The researcher conducted most of his research during lunchtime or after hours. Therefore, research did not affect work related matters.
Meeting Supervisors' deadlines	The researcher worked on the supervisors' comments during the night to meet deadlines and attended scheduled meetings.
Researcher's notebook was stolen	Although the researcher's notebook was stolen, when his cars was broken into, the researcher kept a hard drive at home locked in safe and this hard drive was updated on regular bases.
Challenges of writing as an academic	The researcher was able to adapt to the supervisors' guidance and followed instructions thereby aligning himself with required standard of writing as academic meeting the standard thereof. Publishing a peer-reviewed-article was a major milestone as this enabled the researcher to understand and learn how to meet certain specifications as per the publishing Journal. Furthermore, the researcher got maximum support from his supervisors.
Conducting research whilst sick	Although there were times when the researcher was sick, however, he had to work hard to cover the lost time.
Fear of failure	There were times when the researcher wanted to give up, however, support from academic friends and family kept him going. Moreover, the fear of failure kept him going.
Moving away from the comfort zone	Based on the challenges encountered at masters' level, the researcher understood that success comes with feeling a sense of discomfort hence the need to move away from the comfort zone.
Losing both parents	The researcher took solace that his parents could have been proud for him to graduate had they been around. Hence, to honour them, the researcher pushed himself spiritually to ensure that the doctoral journey was completed.

Challenges encountered	Mitigation
Financial support	In addressing financial challenges, the researcher applied and received funding from NRF, UNISA and Eskom.
Lack of focus	Motivated by his interest in EMA as well as the mining industry, the researcher remained focused and inspired to complete the doctoral journey.
Getting copyright on time for images used in the peer-reviewed article	The researcher requested permission from his manager and was able to directly call Authors and Professors from countries such as Germany, Australia and London thereby meeting the set deadlines of the Publisher.

6.9. FURTHER RESEARCH

Several avenues exist for further research in this area.

- The final decision-making framework has been obtained through a 3-tiered qualitative approach – literature survey, interviews, and a focus group. Further analysis of the framework could be undertaken through a quantitative validation to bring it closer to be a model for the coal mining industry to reduce cost and mitigate environmental effects. To this end the necessity for coal mining companies as well as their possible lack (inability) to engage in cost-savings measures will be better understood.
- The decision-making framework could be exercised through case studies in specific coal mines. This involves visiting the coal mines for an extensive period to validate the framework in a real-life setting (operational level.) Such endeavour could further assist in eliciting possible past consequences of not having a cost-saving measure on the social and environmental performance of these mining companies.
- The focus group alluded to the applicability of the framework in other industries. Consequently, cost factors and environmental aspects in other sectors could be evaluated on the strength of the decision-making framework to determine its utility in the said industries.
- A similar study focussing on the extent and impacts of the underground fires specifically in South Africa could be undertaken.

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APPENDIX A: INTERVIEW PROTOCOL

Note: Since ethical clearance was granted the title of the study has changed from An information framework to A decision-making framework.

Dear Participant

My name is Mashudu David Mbedzi and I am studying towards a Doctor of Business Leadership (DBL) with the UNISA School of Business Leadership (SBL) based in Midrand. I am currently conducting academic research aimed at developing a information framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry.

PARTICIPANT DEMOGRAPHICS	
Name and surname (**optional**)	
Gender	
Current Position	
Working experience (in years and months)	
Place	
Date	
Time	

- What information is used in the coal mining industry to make decisions with regard to their impact on the environment?
- What information does the coal mining industry need to identify waste?
- What information does the coal mining industry need to minimise cost with regard to their impact on the environment?
- How successful are the existing processes employed by the coal mining industry to make decisions on:
    - their environmental impact, and
    - related cost savings?
- To what extent are you familiar with environmental management accounting (EMA)?
    - If familiar what are the benefits of EMA for the coal mining industry?

- What are the reasons for possible non-implementation of EMA principles and associated management accounting tools by the coal mining industry?
- Which processes ought to be followed by the coal mining industry to make decisions on:
    a. their environmental impact, and
    b. related cost savings?

My sincere appreciation for your time in taking part in this interview

APPENDIX B: INFORMED CONSENT FOR INDIVIDUALS

Graduate School of Business Leadership, University of South Africa PO Box 392 Unisa 0003 South Africa
Cnr Smuts and First Avenue Midrand 1685 Tel: +27 11 652 0000 Fax: +27 11 652 0299
Email: sbl@unisa.ac.za Website: www.sblunisa.ac.za

Informed consent for participation in an academic research project

An information framework to facilitate cost savings of environmental impacts in the coal mining industry

Dear Respondent

You are herewith invited to participate in an academic research study conducted by Mashudu David Mbedzi, a student in the Doctor of Business Leadership at UNISA's Graduate School of Business Leadership (SBL).

The purpose of the study is to develop an information framework to facilitate cost savings of environmental impacts in the coal mining industry. All your answers will be treated as confidential, and you will not be identified in any of the research reports emanating from this research. Your participation in this study is very important to us. You may however choose not to participate and you may also withdraw from the study at any time without any negative consequences. You will be required, during the face-to-face interviews, to answer relevant questions. These interviews should not take more than 30-40 minutes.

The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.

Please contact my supervisor, Prof HM van der Poll on vdpolhm@unisa.ac.za or my Co-Supervisor Prof JA van der Poll on vdpolja@unisa.ac.za if you have any questions or comments regarding the study.

Please sign below to indicate your willingness to participate in the study.

Yours sincerely

Mashudu David Mbedzi

I, _____, herewith give my consent to participate in the study. I have read the letter and understand my rights with regard to participating in the research.

_____ _____

Respondent's signature **Date**

APPENDIX C: INFORMED CONSENT FOR FOCUS GROUPS

Graduate School of Business Leadership, University of South Africa PO Box 392 Unisa 0003 South Africa
Cnr Smuts and First Avenue Midrand 1685 Tel: +27 11 652 0000 Fax: +27 11 652 0299
Email: sbl@unisa.ac.za Website: www.sblunisa.ac.za

Informed consent for participation in an academic research project

An information framework to facilitate cost savings of environmental impacts in the coal mining industry

Dear Respondent

You are herewith invited to participate in academic research conducted by Mashudu David Mbedzi, a student in the Doctor of Business Leadership at UNISA's Graduate School of Business Leadership (SBL).

The purpose of the study is to develop an information framework to facilitate cost savings of environmental impacts in the coal mining industry. All your answers will be treated as confidential, and you will not be identified in any of the research reports emanating from this research. Your participation in this study is very important to us. You may however choose not to participate and you may also withdraw from the study at any time without any negative consequences. You will be requested during the focus group to participate in the discussions. The focus group should not take more than 1 hour of your time.

The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request. Please contact my supervisor, Prof HM van der Poll on vdpolhm@unisa.ac.za or my Co-Supervisor Prof JA van der Poll on vdpolja@unisa.ac.za if you have any questions or comments regarding the study.

Please sign below to indicate your willingness to participate in the study.

Yours sincerely

Mashudu David Mbedzi

I, _____, herewith give my consent to participate in the study. I have read the letter and understand my rights with regard to participating in the research.

_____ _____

Respondent's signature **Date**

1

APPENDIX D: PARTICIPANT INFORMATION SHEET

Graduate School of Business Leadership, University of South Africa PO Box 392 Unisa 0003 South Africa
Cnr Janadel & Alexandra Avenue Midrand 1685 Tel: +27 11 652 0000 Fax: +27 11 652 0299
Email: sbl@unisa.ac.za Website: www.sblunisa.ac.za

PARTICIPANT INFORMATION SHEET

2 May 2017

Title: An information framework to facilitate cost savings of environmental impacts in the coal mining industry

Dear Prospective Participant

Student research project

My name is Mashudu David Mbedzi and I am doing research with my Supervisor, Professor HM van der Poll and Co-Supervisor, Professor JA van der Poll towards a Doctor of Business Leadership at the University of South Africa with the Graduate School of Business Leadership. We have funding from the University of South Africa for completion of the studies. We are inviting you to participate in a study.

WHAT IS THE AIM / PURPOSE OF THE STUDY?

The aim of this study is to develop an information framework to facilitate cost savings of environmental impacts in the coal mining industry. Once the framework is developed and approved, it will assist South African coal mining companies to implement appropriate and relevant Environmental Management Accounting (EMA) principles to preserve the environment and its natural capital. Personal interviews and focus groups will be used to collect data.

WHY AM I BEING INVITED TO PARTICIPATE?

Why did you choose this particular person/group as participants?

The researcher used purposive sampling to select coal mining companies as the study focuses on the coal mining industry. Participants were chosen from your companies because they are well versed with coal mining operations.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY /WHAT DOES THE RESEARCH INVOLVE?

The study involves face-to-face interviews and focus groups. Consent forms will be given to you at the start of the personal interviews and focus groups to sign. Data collected will ONLY be used for the purpose of this study. The time allocated to the face-to-face interviews is 30-40 minutes and 1 hour the focus group.

Graduate School of Business Leadership, University of South Africa PO Box 392 Unisa 0003 South Africa
Cnr Janadel & Alexandra Avenue Midrand 1685 Tel: +27 11 652 0000 Fax: +27 11 652 0299
Email: sbl@unisa.ac.za Website: www.sblunisa.ac.za

CAN I WITHDRAW FROM THIS STUDY?

Being in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep for future reference. You are free to withdraw at any time and without giving a reason. You have a right to answer or not to answer some of the questions.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

You will not benefit directly from your participation in the research. You will receive no payment or reward, financial or otherwise. The benefits of this study include, but are not limited to: development of guidelines and a framework to apply appropriate EMA principles, cost cutting measures to realise profit, and improved compliance measures in order to better manage the environment.

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

There are no foreseeable physical or psychological risks involved in participation. You will be mildly inconvenienced by the time it takes to participate in the face-to-face interview (max. 40 minutes) or the focus group (1 hour). If you would like to discuss the research and your reactions to the questions, you are welcome to do so after the session.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by legislation (The Mental Health Care Act, Act 17 of 2002). Confidentiality is, however, not a concern in this research as the questions will be answered anonymously and individual identifiers will not be requested. The data will be destroyed on completion of the study.

The data collected will be used to write research reports, which include but may not be limited to journal articles, conference presentations, and a thesis. Your privacy and that of the company you represent will be protected and no identifiable information will be included in such reports.

APPENDIX E: NON-DISCLOSURE AGREEMENT

CONFIDENTIALITY AND NON- DISCLOSURE AGREEMENT
BY AND BETWEEN

Top Transcriptions ("THE RECIPIENT")

Registration Number: CK 2008/230998/23

And

Mashudu Mbedzi
("THE DISCLOSING PARTY")

Registration Number: STUDENT NO. 72224134

MM

Definitions

1. For the purposes of this agreement:
   1.1. "Transaction" means the provision of services to MASHUDU MBEDZI, by ***the recipient***.
   1.2. "Relevant Information" means:
      1.2.1. all information (whether oral, written or in any other form) relating to "MASHUDU MBEDZI" and the Transaction which is supplied to ***the recipient*** or to ***the recipient's*** agents or to which these agents are allowed access or of which ***the recipient*** or ***the recipient's*** agents become aware of in the course of meetings or discussions with "MASHUDU MBEDZI".
      1.2.2. all information regarding the existence, nature or progress of any approach, negotiations or discussions relating to the Transaction; and
      1.2.3. in each case includes documents and information prepared or generated by ***the recipient*** or ***the recipient's*** agents from such information.

Terms of the confidentiality

2. All Relevant Information shall be kept strictly confidential and ***the recipient*** shall not disclose in whole or in part any Relevant Information to any person other than:
   2.1. those persons transcribing and proofreading for ***the recipient*** or are likely to be directly involved in the Transaction and who reasonably need to know the Relevant Information for the purposes of evaluating or negotiating the Transaction; and
   2.2. those professional advisers engaged to advise ***the recipient*** in respect of the Transaction and who reasonably need to know the Relevant Information (or any part of it) in order to advise upon the Transaction.

3. The Relevant Information shall be used by ***the recipient*** and by any person to whom it is properly disclosed in accordance with paragraph 2 solely for the purpose of evaluating and negotiating the Transaction.

4. This agreement shall not apply to Relevant Information:
   4.1. which at the time of disclosure to ***the recipient*** is in the public domain; or
   4.2. which, after such disclosure, comes into the public domain otherwise than through an unauthorised disclosure by ***the recipient*** or their agents or by any other person in breach of any obligation of confidentiality; or
   4.3. which was lawfully in the possession of ***the recipient*** prior to such disclosure, as evidenced by the relevant party's written records, and which was not acquired directly from or indirectly from "MASHUDU MBEDZI"; or

P MD

4.4. which lawfully comes into the possession of ***the recipient*** from a third party on a non-confidential basis; or

4.5. which ***the recipient*** are compelled to disclose by reason of any applicable law, order of the court or by applicable regulation.

5. If ***the recipient*** or any person to whom Relevant Information is properly disclosed in accordance with this agreement becomes compelled to disclose any Relevant Information ***the recipient*** shall inform "MASHUDU MBEDZI " in writing of such request or obligation as soon as possible after ***the recipient*** are informed of it and, if possible, before any Relevant Information is disclosed, so that a protective order or other appropriate remedy may be sought by "MASHUDU MBEDZI " and the cost thereof shall be borne by the party seeking such protective order. ***The recipient*** agrees to assist and co-operate in any appropriate action, which "MASHUDU MBEDZI" may decide to take at the cost of "MASHUDU MBEDZI", as the case may be. If ***the recipient*** is obliged to make a disclosure, ***the recipient*** shall only make a disclosure to the extent to which ***the recipient*** are so obliged but not further or otherwise.

6. As soon as possible and in any event within five business days after receipt by ***the recipient*** of a written notice from "MASHUDU MBEDZI" requesting it, ***the recipient*** shall return any and all Relevant Information and all copies thereof which have been made by or on behalf of ***the recipient*** or its directors or employees and ***the recipient*** will confirm to "MASHUDU MBEDZI", in writing, that this obligation has been complied with.

7. Each party acknowledges and agrees that damages would not be an adequate remedy for any breach of the undertakings contained herein and "MASHUDU MBEDZI" shall be entitled, without limitation, to the remedies of injunction and other equitable relief for any threatened or actual breach of the confidentiality obligations provided for herein.

8. This agreement contains all the express provisions agreed on by the parties with regard to the subject matter of the agreement and the parties waive the right to rely on any alleged express provision not contained in this agreement. A party may not rely on any representation which allegedly induced that party to enter into this agreement, unless the representation is recorded in this agreement.

9. Notices under this agreement shall be given in writing to the relevant party at the address stated herein (or to such other address as it shall previously have notified in writing to all other parties).

10. This agreement shall be governed by and construed in accordance with South African law and any claims or disputes arising out of, or in connection with, this agreement shall be subject to the exclusive jurisdiction of the High Court of South Africa (South Gauteng Division)

THUS DONE AND SIGNED AT Durban AT THIS THE 25 DAY OF April 2017

For and behalf of: Top Transcriptions

Per (full name of signatory): Paul Crowther

Capacity: Member

THUS DONE AND SIGNED AT Sandringham AT THIS THE 25 DAY OF April 2017

For and behalf of: MASHUDU MBEDZI

Per (full name of signatory): Mashudu D. Mbedzi

Capacity: Doctorate Student

APPENDIX F: SUSTAINABILITY JOURNAL PAPER

Since publication this article the title has changed from An information framework to A decision-making framework.

Link: https://www.mdpi.com/2071-1050/10/6/1690

sustainability

MDPI

Article

An Information Framework for Facilitating Cost Saving of Environmental Impacts in the Coal Mining Industry in South Africa

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Received: 11 March 2018; Accepted: 16 April 2018; Published: 23 May 2018

Abstract: Coal mining contributes much to the economic welfare of a country. Yet it brings along a number of challenges, notably environmental impacts which include water pollution in a water scarce country such as South Africa. This research is conducted in two phases. The first phase intends to establish environmental and other challenges brought about by the coal mining industry through a comprehensive analysis of available literature. Combatting these challenges is costly; consequently, our work investigates how established management accounting tools and techniques such as Environmental Management Accounting (EMA), Material Flow Cost Accounting (MFCA) and Life Cycle Costing (LCC) may facilitate cost savings for the companies involved. These techniques promote increased transparency of material usage by tracing and quantifying the flows and inventories of materials within the coal mining industry in physical and monetary terms, hence hidden costs are elicited. The researchers postulate that an Information Framework integrating these aspects may be the way forward. To this end existing frameworks in the literature are identified. A

number of research questions embodying the above aspects are defined and the objective is to define a conceptual framework to facilitate cost savings for coal mining companies. The main contribution of this work is an information framework presented towards the end of this article. The second phase of the research will involve fieldwork in the form of a survey among stakeholders in industry to validate the conceptual framework.

Keywords: coal mining industry; cost saving; EMA; environmental impacts; information framework; LCC; MFCA; Monetary EMA (MEMA); Physical EMA (PEMA)

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1. INTRODUCTION

The coal mining industry in South Africa contributes much to the country's economic welfare and offers lucrative investment opportunities, yet brings about a number of challenges, for example environmental impacts and compromising the health of workers. By far the most severe problem is the rise in the contamination of water, for instance, water in one of the South African Provinces, Mpumalanga, the Middelburg dam is estimated to be 40% unsuitable for human consumption. The critical challenge facing South Africa is to propose and provide policies and frameworks that are effective and integrated; and to implement resolute capital approaches to generate foreign capital inflows and platforms that ought to mitigate the problems that are indicated above. This should ensure that South Africa as a country is aligned to viable improvement, whilst taking full advantage of the prospective export profits through the export of coal [1]. The coal deposits in South Africa are located in what is referred to as the Karoo Super group. This is a dense categorisation of alluvial rocks that have been deposited during a period ranging from 180 to 300 million years. These coal layers are found in the segment known as the Ecca subgroup, made up of mudstones including sandstones. These coal deposits that were placed in large river environments appropriate for the development of coal did not transpire in all places, and these coal deposits are fairly limited, mostly occurring in the basin of the Karoo. The stretch of the basin ranges from Welkom in the Free State province to Nongoma in Kwa Zulu Natal. It is also estimated that about 50% of the coalfields in areas such

as Emalahleni, Ermelo, and Highveld encompass the deposits of coal that may be recovered [2].

1.1. CORPORATE SOCIAL RESPONSIBILITY

Corporate Social Responsibility (CSRx) (x = 1 or 2—see below) is a generic for two forms, namely Corporate Social Responsiveness (CSR1) and Corporate Social Responsibility (CSR2) [3]. Modern companies, including coal mining companies are run by CEOs, managers, etc. and understandably it is in the interest of management and the owners to maximise profits and create a long-term and sustainable competitive advantage. In this process, however, those in control often lose sight of environmental issues, and the effect their company has on the environment. Consequently company (mining) boards of control were formed. These boards usually represent the interests of other stakeholders, e.g., shareholders of the company, or in our case coal mining companies, and guard against managerial opportunism. Since boards themselves may be compromised in their noble objectives, [3] recommends that ordinary employees, but especially members from the local community ought to have membership on these boards. Presumably then, such community leaders would monitor company (mining) activities since it would affect them and their environment in which they live directly.

1.2. CSRX AND THE IT INFORMATION SYSTEM

Plausibly because of the above CSRx aspects, modern companies, e.g., the coal mining industry and their shareholders have become progressively concerned regarding matters relating to the environment. In the same context, the purpose of an information system (IS) and information technology (IT) in various companies concerning environmental sustainability has been transformed. Specific programmes and projects are considered to be reliable in striving towards a society that is sustainable. The fundamentals contained by an IS/IT assessment as well as expenses, profits and risks in companies linked to the appraisal of IS and the avoidance of the depletion of natural resources so as to maintain an ecological balance are being considered in relation to the major obstacles regarding sustainability processes. This compels companies to endeavour to lessen the

influence of their IS/IT activities in a social and ethical manner towards the environment [4].

An IS is a multifaceted communal item that emanates from embedding technological structures within a company wherein technical and matters of social nature are gradually entangled, combined with a wide range of moral decrees and actions. These are predisposed by societal ideals, welfare of political nature and the contestants' specific delineations of their state of affairs paramount to the execution of such a system [5]. To this effect, [6] considers an IS as a community system entrenched in IT. Logically such entrenchment does not avert the complete unit from being a societal structure, and it might not be probable to develop a rigorous and efficient IS, integrating substantial technology without looking at it as a societal system.

There appears to be no simple solution to modern environmental problems and societal challenges facing humanity, hence there may never be scientific certainty or agreement [7]. Key environmental problems that have been caused by coal mining include amongst others: sterilised land; Acid Mine Drainage (AMD); underground fires and sink holes from abandoned mines. Human diseases include: pneumoconiosis, asthma, and hyperpigmentation (appearance that depicts patches or a flushed complexion). The coal mining companies in South Africa also need to comply with good corporate governance as stipulated by King IV [8], yet such compliance coupled with minimising environmental and health impacts may be costly. Subsequently, the researchers postulate the need for an information framework embedding Environmental Management Accounting (EMA) principles to facilitate cost saving of environmental impacts for the South African coal mining industry and to guide companies to decrease their environmental footprint. King IV compliance may be largely absent, for instance, voluntary implementation of King IV by coal mining companies is insufficient as these companies may focus on generating profits only, rather than saving the environment in which they operate. Furthermore, coal mining companies should be accountable and responsible to ensure they mitigate negative impacts on conservation. Consequently, an information framework to facilitate cost savings of environmental impacts should be one of the essential tools for coal mining companies in South Africa. The above problem statement informs the following research questions.

(1) What challenges are generated by the South African coal mining industry? (RQ1)
(2) Which frameworks exist to facilitate cost saving of environmental impacts for the coal mining industry? (RQ2)
(3) What management accounting tools and techniques may be used to facilitate cost saving in coal mining companies? (RQ3)

Our research objective is to:

Develop a conceptual information framework to facilitate cost saving of environmental impacts for the coal mining industry in South Africa (RO).

2. LITERATURE REVIEW

Mining operations may have a harmful bearing on society and the physical environment in many different ways. Some of these effects and health impacts are discussed in Section 2.1 and 2.2 thereby addressing the first research question (RQ1).

2.1. EFFECT OF COAL MINING ACTIVITIES ON THE ENVIRONMENT

Numerous coal mining undertakings may lead to the contamination of soil and water that flows beneath the earth's surface thus filling the permeable spaces. These consist of: leakage from metropolitan and/or mine dumps that have chemical substances; mining sites that have been deserted; chemical leaks that occur by accident; indecorous subversive disposal of watery discharges; the strategic placing of tanks to collect liquid waste in hydrological and ecological sites; and inopportune application of manures and pesticides meant for agrarian and home procedures [9]. All these undertakings impact on the confined societies wherein the mines are located.

In a study enquiring into the influence of the excavation of coal and how it impacts the populace assembly of plants in Jaintia Hills neighbourhood of Meghalaya, North East India, the authors of [10] established that widespread mining of coal in this area caused contraction of the usage of land, and the cover of land; and caused a scenery that is deformed with mine plunders. The disruption due to mining activities has lessened the prospects of reviving of the plant types, resulting in plummeting of the quantity of species in the areas that have been excavated. The number of herbaceous species occurring in the excavated provinces remained established, greater as compared to the areas that were not mined. Thus, quarrying undertakings are considered to be detrimental to the plant diversity.

The phrase ‘origin of threat’ implies the derivation of the threats, for instance, polluted water emanating from the mined area; the alleyway as a way through which the danger stretches to a receptor for example, leakages and leaks of polluted water to ground and surface water; and a surge in other possibly unsafe biochemical spills. These chemical spills have the ability to damage aquatic flora and fauna, including other plant types at trophic intensities higher up in the food chain, particularly plant species that may not withstand the upsurge in high levels of metal content in waste water [11]. Coal mining companies should, therefore, operate within the relevant environmental policies to avoid environmental degradation, human diseases, and air pollution. The ‘source of risk’ model demonstrates clearly how coal mining operations may affect the natural environment; human health; and flora, and fauna in terms of health hazards. Contamination due to mining activities from one mining project for instance, may disturb a wide range of square kilometres and AMD may sterilise the environment, making it unsuitable for plant growth for many years to come. Notwithstanding the undeniable proof of the conservational destruction triggered by excavating coal during the preceding years, the business holistically encouraged the corporate oxymoron of ecological quarrying of land [12].

Therefore, coal mining companies should control the discharge of AMD into the environment.

2.2. HEALTH IMPACTS OF COAL MINING ACTIVITIES ON HUMANS

In a study enquiring into nuisance dust, un-protective exposure to the levels of dust caused by mining activities in the in the USA, 1934–1969, the authors of [13] established that dependence on this deceptive precaution, and the expansive perception of the nontoxicity of dust from the coal mines caused detrimental environmental challenges. An epidemic was caused by dust and, hence, led to the eminence of chronic respirational illness that affected many mine workers in America’s bituminous and anthracite coal mining areas just before the 20th century. By 1969, the US Surgeon General predicted that about 100,000 miners including ex-mineworkers were affected and were sick from pneumoconiosis, anthracic-silicosis and illness that affects the lungs. Similarly, the author of [14] maintains that more miners are suffering from the pneumoconiosis and other occupationally induced diseases. Therefore, regular health checks should be implemented by the coal mines so as to identify imminent diseases that may affect the miners.

Fire and eruptions are both serious hazards that occur in a mine when any of fuel (methane and coal dust) and oxygen mixtures, followed by an ignition such as electrical abrasion; smoking; or chemical reactions occur in mines. On 20 November 1968, 78 of 99 employees of the mine lost their lives due to a major blast at Consolidation Coals Farmington No.9 in Farmington, West Virginia. Due to the fact that coal is essentially carbon, it oxidises to produce heat, thereby creating a hazard. With the exception of anthracite, all grades of coal are subject to spontaneous heating and ignition. Since spontaneous heating is cumulative, coal is most dangerous 90 to 120 days after it has been mined [15].

Other additional hazards such as machinery also account for many injuries and fatalities in the mines. Roof bolting equipment and power drills are often involved in mine accidents. There is also a danger associated with the use of explosives. Incorrect blasting may cause fires and explosions, and by-products of explosion, such as carbon monoxide and nitric oxide, may poison or kill workers. Miners who breathe dust could develop lung cancer or other respiratory diseases such as black lung disease. Since the majority of mining explosions occur underground, coal mining companies ought to continuously monitor underground working conditions [15].

Imminent health hazards and challenges exist in the Balkans and these include health complications due to coal that is in the ground. Lignite for instance has been identified a contributing element of critical, devastating disease that affects the kidneys and also linked with urinary track cancers. The ailment recognised as Balkan endemic nephropathy (BEN) occurs in groups, such as the villages in the former Yugoslavia and Romania. [16] Further argues that from the time records were retained in the 1950s, hundreds and thousands of individuals in the prevalent villages are assumed to have passed on due to kidney lapses and related complications. Burning coal seams that may not be managed around the world are dominant in China, India, and South Africa. Emissions emanating from these fires include high concentrations of chemicals such as benzene, toluene, xylene, and ethylbenzene [16].

In South Africa for instance, the author of [17] reports that the Blesboklaagte region which is located in the eastern part of the Ferrobank industrialised zone, in Emalahleni, Mpumalanga has been undermined as is demonstrated by board and pillar structures that have collapsed, as well as the existence of coal disposal dumps. When the mining operations ceased for instance, the original board and pillar, the

shallow roof of the mine then curved in and warped, over a wide area. These subsidence landscapes may be noticed in suburban areas including the deserted parts south of the airfield and north of an informal settlement. Warning signs serve as a reminder that the area is not safe as depicted by the markings on the tar road. The major challenge and hazard is that dwellers from the informal settlement walk across this area daily unaware of the dangers they are faced with. Figure 1 depicts a burning collapsed coal mining area (sink hole).

Figure 1. Blesboklaagte burning collapsed coal mining area (sink hole) (*Source:* [17]).

Over a period of time, crystalline silica (also known as silica) dust has since been renowned as a danger to human health as it affects the lungs and causes breathing problems. During subversive quarrying operations, the silica dust is formed from many sources for instance, cutting, drilling, or grinding of the rock structure. This rock material in normally found as an innate component of the coal, however, it is typically not a substantial foundation of silica [18]. According to the authors of [19] most major mining operations executed through the open cast mining method cause dust. Key activities that result in dust being produced include drilling, blasting, stacking, unstacking, and conveying of coal. Therefore, this dust impacts on the environment as it affects the quality of air

within the vicinity of the mine and local communities thus creating health hazards.

In a similar study enquiring into the health effects of the use of coal in residential households in China, the authors of [16] established that most types of coal experienced mineralisation, causing imminent affluences that are toxic, for example, fluorine, mercury, antimony, and thallium. The use of the mined coal with high content of carbon in domestic stoves that do not have air vents exacerbates the poisonous components in emissions. The condition is worsened by the exercise whereby crops are left to dry above the coal fires. People who are affected reveal characteristic signs

of arsenic exterminating, as well as hyperpigmentation, hyperkeratosis (shows a skin that is peeling commonly mostly on the feet including hands), Bowen's ailment (black, horny, precancerous skin scratches).

The authors of [20] established that soil comprising substances such as arsenic, lead, and nickel are expressively associated with the prevalence of biological deficiencies. Thus, residents located in central Appalachia, where considerable and expansive coal mining activities occur, are subject to a higher level of risk in contracting main depression and major psychological anguish in relation to other regions of Appalachia [21].

The discussions in Sections 2.1 and 2.2 answered our first research question, namely: What challenges are generated by the coal mining industry? (RQ1)

Next, Section 2.3 and 2.4 address research question 2 (RQ2).

2.3. ENVIRONMENTAL MANAGEMENT ACCOUNTING

Environmental Management Accounting (EMA) is considered as the procedure for managing conservation and performance aspects through developing and implementing relevant accounting systems and practices relating to the environment. This includes but not limited to some companies providing reports and conducting environmental audits. EMA encompasses the analysis of LCC, full cost accounting (FCA), complete assessing of related benefits, and strategic ecological management planning [22].

On the outward evaluation of EMA, specifically in other contexts, it is also known as environmental financial accounting (EFA) that offers both financial information and ecological to external interested parties for instance stockholders, rating authorities, ecological governing authorities and statistical companies on the performances of business and level of risks. Green safeguarding projects, intending to minimise releases and wastes at origin (circumvention decision) by enhanced use of raw materials and calling for less (detrimental) operational materials are frequently not acknowledged and applied [23]. As a result, the cost-effective and environmental benefits to be attained from these processes may not be applied by the coal mining companies.

EMA is considered to equally apply to financial and physical issues of conservational accounting.

Physical EMA (PEMA) taking into account energy and the flow of water, whereas monetary EMA (MEMA) addresses expenditures relating to the business utilisation of natural resources and the expenses for averting conservational damages [24]. Similarly, the author of [25] argues that EMA is a means premeditated to manage fiscal and non-fiscal eco-friendly undertakings in businesses. It is turning out to be most imperative for inventiveness of an environmental nature and routine management activities such as the design of products; control of costs and apportionment; pricing of products; and performance appraisal. In the same line of thought, the author of [26] contends that in addition to creating value for the consumers by bringing into being and delivering products that are ecologically friendly, companies must disclose their monetary enactment through the appropriate review of conservational costs in their cost accounting systems.

2.4. ANALYSING THE DETERMINANTS OF EMA ADOPTION

The development of EMA regarding waste management in local governments in Australia was influenced by social structural inspirations and company contextual encouragements. With reference to a case study in New South Wales (NSW) that was conducted on the twelve local municipalities, it was established that clement levels of EMA information is being utilised for the management of waste. It was further argued that initiatives such as recycling, physical and financial accounting for solid and liquid waste in these councils were much higher as compared to those of indirect and external cost; and effect on waste management accounting [27].

In Malaysia, the authors of [28] established that sociological alignment may directly impact the company systems thus bringing about backing for the new institutional sociology viewpoint of institutional theory, wherein tough pressure of normative and isomorphism were identified as having a positive influence on the embracing level of EMA. Most significantly, the research indicates the essential role played by academic institutions such as accounting associations, policymakers, the department of education (DOE), the Inland Revenue Board including EMA adoption by companies specialising in manufacturing in Malaysia.

In Germany, the authors of [29] undertook a study on adopting corporate environmental systems and established that compliance of controlling nature and lawful certainties were major inspirations for the adoption of eco-friendly practices in the gas and energy businesses. Similarly, the authors of [30] argue that in Zimbabwe, environmental compliance and pressures stem from regulatory institutions such as the Zimbabwean Revenue Authority (ZIMRA). Most administrations are regularly faced with key challenges of articulating policies and procedures that address manifold scale goals. Some major challenges include but are not limited to upholding high social and ecological values; and non-financial results that are challenging to put a price on for example a cleaner atmosphere or enhanced health of the community [31]. The hazardous manufacturing and risky businesses for instance, companies dealing with the manufacturing of chemicals are expected to be proactive through legislative requirements to adhere to conservational managing undertakings [32]. Therefore, regulatory authorities motivate coal mining companies to comply with environmental policies.

Different societies worldwide are progressively expecting and needing a more substantial stake of reimbursements from the excavation projects based in their local communities, to be more included and involved in making of decisions, and guarantees that the processing of minerals will be carried out in a safe and responsible manner. These developments have been prompted by the upsurge evolution of the paradigm shift in ecological improvement (with its equivalent emphasis on the societal magnitudes of development taking into account the necessity for partaking in the taking of key decisions by the public) including expansive governance changes that have gradually conveyed principal authority towards non-state for instance, market and the public stakeholders in the mining industry [33]. This may be elucidated by the reasoning that a lot of companies are still utilising fragile conservative management accounting systems.

Figure 2 presents a theoretical framework for evaluating the Societal Licence to Operate (SLO) contributing factors and results in the mining industry.

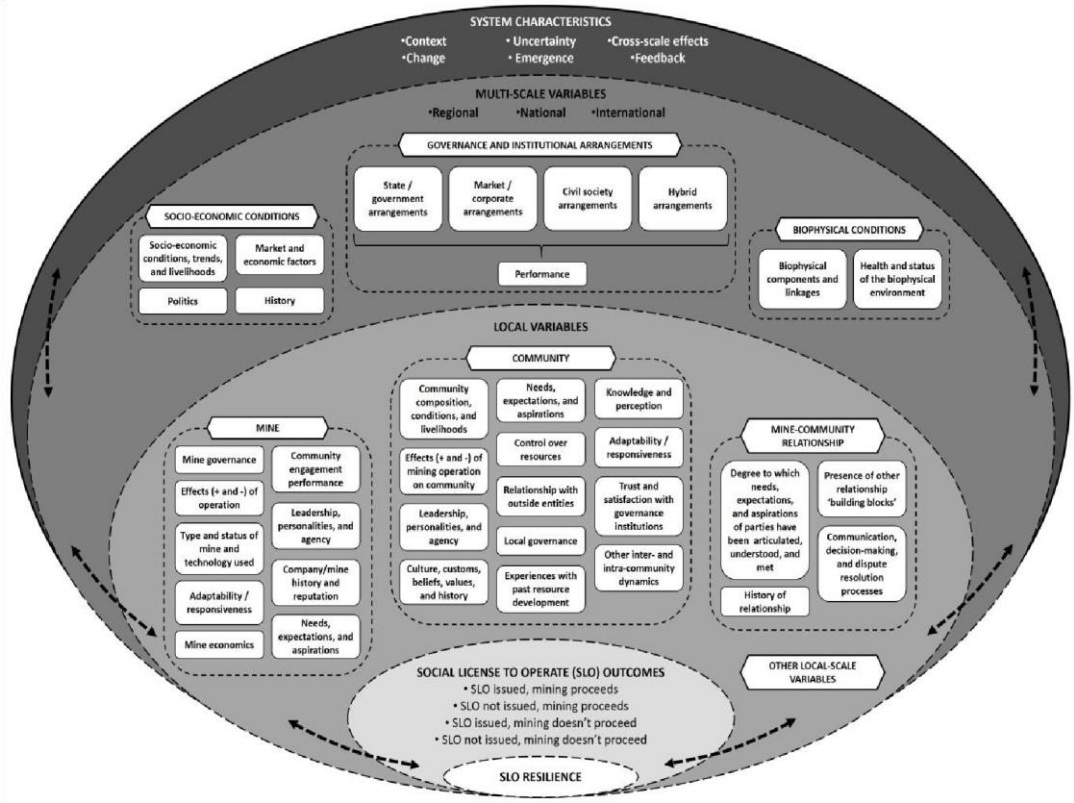

Figure 2. A conceptual framework for assessing SLO determinants and outcomes in the mining industry (Source: [33]).

Figure 2 contextualises a practical scenario applicable to the coal mining environment in South Africa in the sense that coal mining companies operate within multi-scale variables (governance issues) such as regional. An example is regional (Mpumalanga), national (South African national government level) and international (e.g., global coal mining) requirements. This filters into governance and institutional arrangements. Socio-economic conditions indicate the livelihoods of the local communities in which these coal mining companies operate and the political environment thereof, market, and history of such coal mining activities. An example of a biophysical condition is the health status of the environment in which these coal mining activities occur.

The LOCAL VARIABLES section in Figure 2 specifies coal mine relations in terms of how these coal mines are administered; how they interact with the local communities; their reputation; and community aspirations of expectations. For instance, a community in Lephalale or Emalahleni might expect the local coal mining companies to employ or give preference to local people instead of people from other provinces even if the local people are not sufficiently skilled, thereby creating role conflict.

Furthermore, this might affect the reputation of the local coal mining companies. Similarly, community variables may include community needs, conditions, knowledge, perception, and local control. Mine-community relationships are significant in the sense that the degree to which needs and expectations are met may determine the level of trust and engagement (reputational image).

This is consistent with the argument in [34], claiming that factors influencing EMA success such as EMA adoption, EMA implementation, business corporate strategy, business plan, government legislation/policy, environmental sustainability, and financial resources may have an effect on business reputational image; net profit; business sustainability and trust by society; business growth; and EMA compliance.

The preceding factors lead to SLO outcomes such as the issuance or non-issuance of SLO proceeds for coal mining companies. Lastly, these factors and other local scale variables (Figure 2) could well lead to SLO resilience by the local communities. It should be noted that this process is iterative in nature [33]. Although this framework has been developed for the South African coal mining environment, it does not directly address the important aspect of an information framework to facilitate cost saving of environmental impacts specifically for the coal mining industry in South Africa.

2.5. A CONCEPTUAL MODEL FOR COAL MINING OPERATIONS AND ITS ENVIRONMENTAL IMPACTS

Human and environmental receptors are highly sensitive to the discharge of chemical affluences due to the excavating activities. Repetitive counteractive verification and controlling of risk are fundamental for directing the focus and resources on the potentially utmost destructive risks, identified through stressful evaluation of risk [11]. Since coal mining is a complex operation, proper risk management should be taken into account by coal mining companies. Figure 3 demonstrates the conceptual model of coal mining operations.

The discussions in Section 2.5 and 2.6 above answer the second research question, namely: Which frameworks exist to facilitate cost saving of environmental impacts for the coal mining industry? (RQ2) Section 2.6–2.8 below address research question 3 (RQ3).

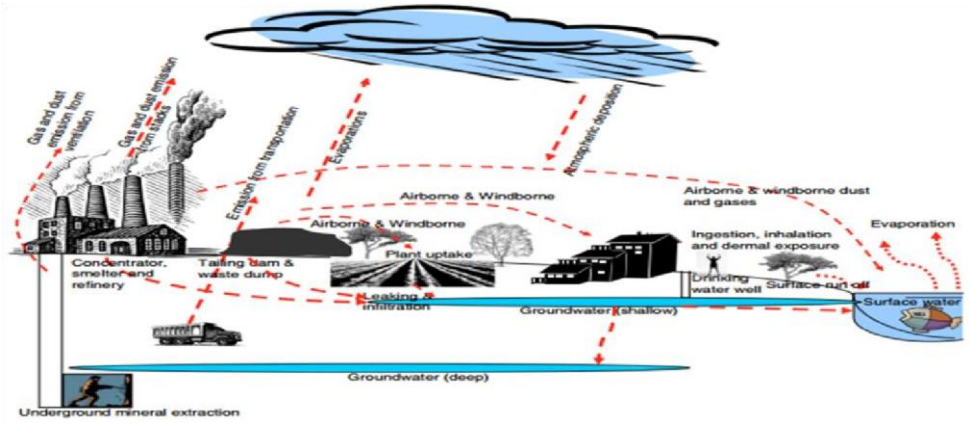

Figure 3. Conceptual model of mining operations (Source: [11]).

2.6. DEFINING MATERIAL FLOW COST ACCOUNTING (MFCA) IN THE PERSPECTIVE OF EMA

In order to comprehend MFCA, its origin and background ought to be explored. MFCA as it later appeared in the International Organization for Standardization, the ISO 14051 standard emerged of national significance regarding projects of conservational nature in fabric companies in Kunert in Southern Germany during the late 1980s and the early 1990s [35]. The author of [36] describes MFCA as a means for measuring the movements of materials inventories in the lines of production in both physical and financial units. MFCA as the main tool of EMA endorses an improved transparent materials usage based on the increase of a material flow that captures and calculates the input and output of material inventories amongst companies in both physical and monetary terms. MFCA identifies quantities of each material and its costs (including material, processing and waste treatment costs).

Figure 4 demonstrates that the physical quantities may be considered under PEMA and the monetary values as MEMA. This is due to the fact that purchased physical units or inventories are needed as inputs to the production process, leading to products that may be converted into cash to generate revenue (profit). The framework presented in Figure 4 is applicable to the coal mining companies; subsequently, they should be prudent in dealing with emissions to air; soil and water; and solid- and liquid waste. This framework demonstrates the operational process, making a start at addressing the need for a cost saving information framework for coal mining companies in South Africa.

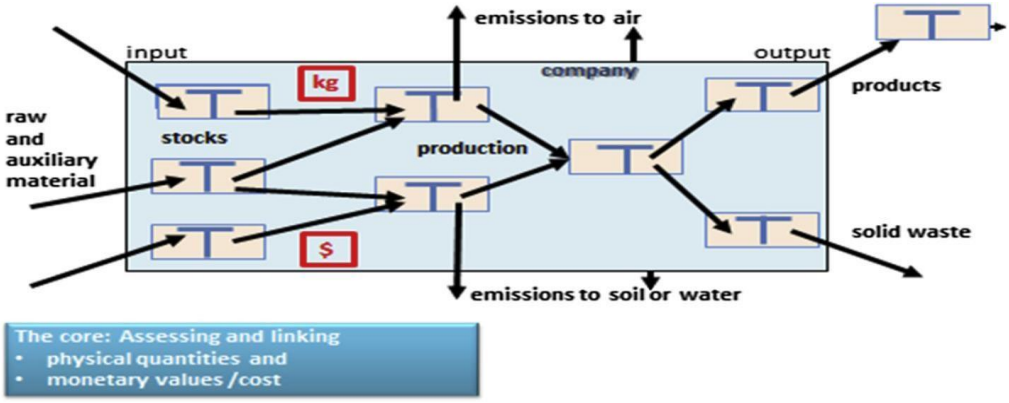

Figure 4. The link between physical quantities and monetary values (Source: [35]).

According to the author of [37], MFCA as a tool of EMA provides a positive prospect for the accountants to collect information relating to the amount of waste generated through the production processes over and above those made available by conservative accounting structures. Waste produced by companies affects both overheads and the atmosphere in many ways for instance lost earnings through an amalgamation of lost resources and expenses associated with the disposal of such materials. Furthermore, the author of [38] suggests MFCA may be observed as a methodology that has been directly and ultimately predisposed from numerous standpoints. The flows of material and the environmental bearing of dematerialisation have acknowledged consideration from conservational economics and cleaner production (CP) in addition to the field of managerial accounting.

With the ecological management issues of the 1990s, the matter of decreasing operative resources and input of energy was well thought-out as a mutual objective of monetary and ecological benefits. Initially, methods based on flow cost accounting were applied. This approach sought to compute and assess the flow of energy and material of a certain definite production line, firstly as a mass (in kilograms) and linking these to current cost accounting. Furthermore, this led to the development of residual material cost accounting that embraced the same method meant to compute the costs accrued in the remaining materials emanating from the manufacturing process. This also functioned based on the measures stated in kilograms. Further to the disposal expenses, the material residual expenses consist of the value of material resultant from the acquisition of unprocessed supplies, storing charges, outlays associated with the management of residual materials and overheads incurred in the protection of the environment [39].

According to [23] materials flows are recorded in kilograms through an input-output inquiry which is the foundation of conservational performance developments and for measuring the quantities and expenses relating to non-product output (NPO). The confines of the system may be at strategic level and may be subdivided into different sites, cost centres, procedures, and commodity lines in case of manufacturing companies. The balance in the flow of material is a calculation based on the assumption that whatever enters should also exit, or must be put away. In terms of the balance regarding the flow of materials, statistics for the utilised resources and the subsequent quantities of product, discarded material and emissions should be indicated. All substances are assessed in physical units in form of mass (Kg, tonnes) or energy (MJ, kWh). The procured input is validated with the manufactured quantities including the resultant unwanted materials and discharges. The objective is to financially and ecologically advance the productivity of managing material.

Contrary to conventional cost accounting methods, flow cost accounting and the remaining resource costs are grounded on the mass system that is expressed (Kgs) and the outcomes are articulated in financial terms (e.g., US$ or ZAR). These two methodologies assign a cost element to the outstanding supplies of a manufacturing line hence recognising the remaining resources as a further charge per item [39].

2.7. BENEFITS OF MFCA

MFCA was assessed at Canon, a Japanese company on the production of their lens with special emphasis on the efficiency of their production lines regarding the crushing procedure. Conventional accounting indicated a 1% loss on faulty products. Almost 32% of the process expenses might be assigned to overheads of material. As a result, having successfully implemented MFCA, the methodology was embraced at the 17 Canon production locations in Japan and overseas bringing about in an overall saving of US$51 million in the period 2004 and 2012. These savings were attributed to the competent use of resources leading to enhanced economic and conservational performance. The study further revealed that amid 20% and 30% of costs were essentially non-product output costs. MFCA facilitated the businesses to detect loss of materials that were up to that time concealed in their production practices [40].

Eco-efficiency can be regarded as an extent that combines information relating to both financial and physical aspects about the green performance of companies [41]. A

provisional standard and guidelines in Japan articulate that eco-friendly data is an indispensable pointer and have a duty to be developed by an EMA system and integrated into company financial statements for reporting purposes regarding conservational matters.

In Indonesia, the authors of [42] established that for the country's cement industry, they could comprehend the significance of encouraging industrial symbiosis at the far-reaching level through utilising the process of material flow analysis (MFA), life cycle analysis (LCA), and MFCA in a cement factory. In a case study exploring the application of MFCA in the JBC food company in the Philippines [43] ascertained that the MFCA approach revealed that about 10% of total production costs were caused by material losses. Peanut skin (6.3%) and rotten peanuts (2.4%) in boiling and peeling contributed most to these avoidable costs, followed by broken peanuts (0.8%) in cooling and selecting processes.

Taking into account comparative benefits over current practices and reliability with prevailing objectives of the company, it was established that ISO 14051 as a regulation standard, by combining financial as well as statistics of a physical nature as a basis for proficient actions, was possibly to encourage acceptance by executives and to fast-track the dispersal of MFCA in a profitable way. Companies conversant with similar ISO excellence, ecological management principles, and related technology may decrease the level of complication and also affluence administrators into implementing MFCA with its prospective for progressive development in eco-friendly and financial enactment [44].

Furthermore, the author of [45] ascertained that when companies are confronted by diminishing natural resources, they ought to considerably advance their material innovativeness. In order to achieve a proficient use of natural resources, MFCA is an aiding tool. Nevertheless, in order to attain resource efficiency as one of the major objectives, businesses should bind themselves from corporate level. This commitment should filter down to all operational levels through the implementation of management control systems (MCS). As a result, businesses must consider applying MFCA as a tool to cut cost and to eliminate unnecessary waste.

2.8. LIFE CYCLE COST (LCC) ANALYSIS

LCC being a set of systematic tools that belongs to a group of the life cycle methodologies is defined as a technique of computing all costs relating to the merchandise (consisting both goods and services) generated through its life span. Life cycle processes are the tools, programmes and procedures that facilitate decision-making with regard to the life cycle of products. LCC is sometimes utilised for decision-making regarding product design, development, and procurement of these products as well as any processes, activities, and public policies related to them [46]. Furthermore, the author of [47] posits that the LCC method could incorporate prevailing monetary data such as cost information that indicates the metrics of life cycle methodologies. LCC involves the benefits and costs that someone has invested, for example, the amount that the manufacturer, transporter, customer, or any other directly or indirectly involved shareholder invested.

Several outdated cost-accounting structures lead to inappropriate investment judgements regarding environmentally friendly overheads. The key challenge is that destruction and costs associated with reconditioning fall outside the periphery of the outdated accounting system. Therefore, LCC has been advocated to resolve this challenge. On the other hand, this might not be a suitable solution since LCC was traditionally not created in a conservational perspective. In a traditional point of view, LCC was considered as a form of investment calculus utilised as a means to classify various investment options. Another objection relates to the boundaries of the LCC system in that the major variance between traditional investment calculus and LCC is that the LCC method has a broader life cycle standpoint. This is due to the fact that it does not only contemplate investment costs, but also considers operational costs during the expected life span of a product. It is imperative to highlight that an outdated LCC does not turn into an eco-friendly accounting instrument due to the fact that it encompasses the words ‘life cycle’ [48].

In a study enquiring into integrating LCC and LCA using extended MFA, the author of [49] argues that the scope of LCC entails specific financial issues directly or indirectly triggered by the product process. This includes the input of raw materials based on the procedures from upstream that are vital in comprehending the product. All the expenses associated in each stage of the life cycle of the product should be included in the final pricing of the services or products as part of the procurement costs for the

next buyer. This implies that expenses and risks incurred on the upstream processes are then passed from one actor to another. In the same context, all the downstream effects of financial nature must be indicated by remaining (residual) amounts.

LCC is furthermore, considered as a means for assessing short-term decisions on whether to invest and for aiding long-term decision-making at corporate level [50]. Specifically, LCC prides itself for reasonable valuations investments that are complicated, for instance, investment decisions regarding construction projects or procurement of capital equipment. In assessing similar projects, LCC can thus be recognised as the total of actual investment and the current value of recovery (salvage) which can in some way be the transactions price at the end of the actual period. In a study enquiring into the application of an LCC methodology in assessing the quality of food produced in Italy, [51] established that LCC may be a convenient logical tool of expediency in creating and controlling investments. The use of the LCC model has largely been restrained to the scrutiny of the utilisation of costs during the life cycle of a product.

There may be hidden costs incurred by coal mining companies as discussed next.

2.9. HIDDEN COSTS THAT MAY BE INCURRED BY COAL MINING COMPANIES

In classifying conservational costs, EA vocabulary utilises phrases such as ‘full’, ‘total’, ‘true’ and ‘life cycle’ to accentuate that the scope of the traditional methods was not complete as it disregarded essential environmental costs (and possible cost savings and profits). Most of the environmental costs are listed and accordingly classified in this section.

The United States (US) environmental protection agency [52] argues that exposing and distinguishing ecological outlays relating to the merchandise, procedure, and structure are crucial for taking effective decisions. Accomplishing these objectives as decreasing green costs, increasing profits, and improving conservational performance necessitates paying consideration to recent, forthcoming, and probable environmentally friendly overheads. How a business delineates ecological expenses is subject to how it anticipates utilising the information for example, allocation of expenses; capital planning; design of a product; or other relevant decisions that may be considered by management. It is sometimes difficult to classify costs for instance, determining of the cost is conservational or partly environmental (grey zone). Whether

the expense is eco-friendly may not be important, however, the aim is to make certain that appropriate overheads receive fitting consideration.

Some researchers, e.g., the authors of [53], argue that 'environmental cost' is sometimes defined very narrowly as being expenditures on pollution control equipment that are installed only for environmental reasons. In other cases, it has a broader definition which incorporates expenditure on areas such as energy efficiency which might well have been undertaken more for commercial than for environmental reasons. This is because of increasing difficulty of separating business costs from environmental costs as environmental considerations are built into mainstream investment decisions. Sometimes the usage also includes the notion of opportunity costs, that is, forgone income and other benefits that might have resulted from alternative courses of action to those that are actually pursued. Calculations of environmental benefits often turn to be primarily composed of avoided costs, based on future projections of regulatory or other trends.

Table 1 depicts the examples of environmental costs from the literature that may be incurred by coal mining companies.

Table 1. Examples of ecological expenses experienced by coal mining companies.

Potential Hidden Costs		
Regulatory	**Upfront**	**Voluntary (Outside Compliance)**
Announcement	Inspection of site	Public liaising
Recording	Clearing of site	Promotional
Monitoring/testing	Authorising	Monitoring/testing
Modelling research	Research and Design	Developmental initiatives
Control	Engineering and commodity sourcing	Auditing
Keeping of records		Qualifying Suppliers
Strategies	Fitting	Reports (e.g., yearly environment reports)
Examinations		
Establishing	**Conventional costs**	Indemnity
Tagging	Investment assets	Scheduling
Readiness	Resources	Viability research
Safety gear	Labour	Mitigation
Medical surveillance	Suppliers	Reconditioning
Conservational	Utilities	Ecological studies

Indemnity	Structures	Research &Design
Spill response	Salvage value	Other environmental projects
Storm water		Designing
Management	Back-End	Fiscal support to environmental groups and researchers
Waste management	Termination	
Disposal of inventory	Discharging	
Financial assurance	Discarding of inventory	
Taxes/fees	Post-closure maintenance	
Pollution control	Surveying the site	
	Contingent Expenditures	
Forthcoming compliance expenses	Mitigation & control	Legal disbursements
Penalties/fines	Property destruction	Natural resource indemnities
Mitigation & control	Individual harm indemnity	Economical loss indemnities
Corporate Image	Rapport with expert staff	Rapport with moneylenders
Customer Rapport	Rapport with employees	Rapport with local societies
Rapport with shareholders	Rapport with providers	Rapport with controlling bodies

Source: U.S Environmental Protection Agency ([52]).

2.10. GUIDELINES OF GLOBAL REPORTING INITIATIVE (GRI)

The global GRI (Global Reporting Initiative) promotes sustainability reporting on company activities, aimed at sustaining company operations as well as the global economy. The authors of [54,55] recommend standard reporting templates, layouts and formats to adhere to the GRI initiative. Their guidelines promote a scenario whereby (amongst other) coal mining companies report their sustainability issues so as to add value in a worldwide viable economy. GRI permits businesses such as coal mining companies to account for their financial- in addition to ecological responsibility. Similarly, mining companies should divulge their conservational effects in deliberation of the South African NEMA Act, 1998 as allied to the GRI sustainability criterions.

The author of [55] defines no fewer than thirty (30) environmental and performance indicators for the mining- and metals industry. Amongst these, indicators 8–10 regulate water usage while guidelines 16–25 address emissions, effluents and waste.

Naturally, these are very (coal-) mining specific as discussed previously in our work. Linking to these are also social performance indicators, notably indicators for Societal aspects and Product Responsibility. Clearly all these apply to the coal mining industry which consumes large quantities of water and generates volumes of emissions and waste.

Even though official disclosure is supportive through the coal mining company monetary statements, GRI suggests that mining companies should reveal lists of shareholders with whom they are involved; their methodologies to engaging with these investors; as well as the approaches of such interactions. All these are aimed at South African coal mining companies aligning to international sustainable ingenuities and to monitor CSRx aspects as discussed in Section 2.1.

3. RESEARCH METHODOLOGY

This article's research methodology follows the Research Onion of [56]. The outmost layer of the onion is the philosophy that has two major components, namely, ontology and epistemology. Ontology is a systematic philosophy, analysing the development of an information framework for facilitating cost saving of environmental impacts in the coal mining industry in South Africa. Hence, an ontological philosophy was used in this study. Looking towards the inner layers, an *interpretivist* philosophy was followed as the researchers interpreted the findings and recommendations in the literature, as well as existing frameworks. The research approach is *inductive* starting at specifics in the literature and working towards a conceptual framework, hence our strategy is a comprehensive literature *survey*. A *qualitative* choice was followed through a rigorous analysis of the available literature, which included scholarly material and mining magazines. Looking ahead, a qualitative survey among stakeholders in industry to validate our framework developed will be done in a next, 2nd phase of the research. Our time horizon as per the onion may be classified as being *cross sectional* since the research was undertaken over a shorter period of time as is normally associated with a longitudinal study (e.g., observing human development from the infant stage to senior citizen). At the innermost layer of the onion, our techniques and procedures of data collection and analysis were through scholarly literature followed by *conceptual analyses* and framework building.

4. DISCUSSION AND FINDINGS

The review of existing literature indicated there are no easy or simple solutions to the environmental problems and the challenges facing modern society, hence there may never be scientific certainty or consensus on how these challenges ought to be addressed. In particular the coal mining industry brings about a number of challenges. Some of the key environmental challenges elicited include:

- water pollution,
- sterilised land that may never be used for agricultural purposes or building,
- underground coal fires,
- AMD,
- human diseases (due to air pollution and polluted water),
- effects on the flora and fauna.

Existing frameworks to govern parts of the (coal) mining industry have been presented, yet none of these comprehensively address the aspects elicited in this work. Subsequently, the researchers postulated above that an information framework to facilitate cost savings of environmental impacts should, therefore, be developed within the context of EMA. The discussion on EMA established that there are two branches of EMA namely MEMA (a monetary part) and PEMA (a physical part). The analysis of the determinants of EMA adoption indicated that in most instances, companies adopt EMA due to regulatory requirements, pressure from non-governmental companies, sociological obligations, and stakeholder concerns.

A discussion on the theoretical framework for evaluating determinants of SLO (refer sub-Section 2.4) and outcomes within the context of the coal mining industry demonstrated that key variables such as systematic characteristics; governance and institutional provisions; socio-economic settings; biophysical circumstances; local variables and SLOs are applicable to the South African coal mining sector. The discussion on the conceptual model for coal mining operations depicted that although coal mining operations may generate profit for shareholders, these operations may also have side effects. In order to address these challenges, MFCA was suggested to be one of the major tools of EMA as it encourages and improves transparency of material usage through the expansion of the flow of materials that also traces and computes the flows and inventories of materials within the coal mining industry in physical and financial terms. The benefits of MFCA showed that the effective use of

input materials may reduce the volume of waste concealed in the production process therefore create revenue. Furthermore, LCC as a technique of computing the overall price of production (encompassing both merchandises and services) and being a systematic instrument belonging to a cluster of the life cycle methodologies, could be utilised in cost reduction.

Lastly, a discussion was conducted on the potentially hidden costs that may be incurred by coal mining companies depicting a list of such relevant costs. However, the term 'environmental', is sometimes narrowly defined as expenditures on pollution control equipment that are installed only for environmental purposes. In other cases, it is broadly defined to include expenditure in areas such as energy efficiency that might have been undertaken mostly on commercial rather than environmental factors.

5. FINDINGS AND DISCUSSION

The review of existing literature established that coal mining operations add value to the GDP of the country, for instance in South Africa 80% of electricity is generated from coal which then powers the processing of other economic minerals such as gold mining which then adds value to the GDP due to revenue generated form exports. In contrast, reviewed literature showed that coal mining operations have an effect on the environment such as leakage of chemical substances from mine dumps, contamination of water due to AMD, deformed landscapes, underground fires etc. In the same context, reviewed literature pointed out that coal mining activities impact on humans by causing diseases such as pneumoconiosis, asthma, and hyperpigmentation (appearance that depicts patches or a flushed complexion).

Reviewed literature also demonstrated that the determinants of EMA adoption were similar in countries such as Australia wherein the adoption of EMA was motivated by social structural inspirations and company contextual encouragements. Similarly, the adoption of EMA in Malaysia was encouraged by sociological, institutional theory, normative as well as isomorphic. In contrast, the adoption of EMA in Zimbabwe was established to be as a result of environmental compliance and pressure from law enforcement agencies such as ZIMRA. However, in South Africa, reviewed literature indicates that the adoption of EMA is on a voluntary basis as per King III and IV Codes. The researchers postulate that when the employment EMA is adopted on a voluntary basis (as is the case in South Africa), ecological degradation will persist whilst coal

mining companies are improving their bottom line, hence focusing on profit and not saving the environment.

This is consistent with the assertion by [34] who argued that factors influencing EMA success such as EMA adoption, EMA implementation, business corporate strategy, business plan, government legislation/policy, environmental sustainability, and financial resources may have an effect on business net profit; business growth; and EMA compliance.

The review of existing literature indicated that existing frameworks do not comprehensively address the mining challenges elicited in the literature. This is echoed by the author of [1], suggesting that South Africa should develop an integrated policy and regulatory framework for its coal mining industry. Subsequently, the researchers postulate the need for an information framework necessary for facilitating cost savings of environmental impacts for the coal mining industry in South Africa, taking into account the aspects elicited in the literature survey.

Furthermore, the researchers postulate that the successful implementation of the proposed information framework will be dependent on whether it is integrated in the corporate strategy, vision and mission of the coal mining companies. As much as the framework depicts clear and concise tolls such as ISO, MFCA, LCC and a green strategy, it will also be subject to whether the management of these coal mining companies understand and have the know-how of successfully implementing and applying these tools.

Such a conceptual information framework is presented in Figure 5. It includes many of the environmental aspects mentioned before as well as the management accounting tools and techniques to facilitate cost savings for the industry. Regulatory aspects are acknowledged, notably [36] which calls for the use of MFCA as part of EMA to promote increased transparency. Likewise the use of LCC as a decision-making tool [46] has been included in the preliminary framework presented in Figure 5. The conceptual information framework is in response to our objective (RO).

Discussion

Our framework in Figure 5 acknowledges PEMA (Physical Environmental Management Accounting) and MEMA (Monetary Environmental Management Accounting) as the main role players in the EMA arena. These two sub disciplines provide the information for various tools and techniques used in these, e.g., ISO, MFCA, etc. One of the drivers in this area is an adherence to green environmental aspects, a key objective of EMA. Naturally these tools and techniques control (determine) the purpose of this research, amongst other an improved environment and lower costing (higher profit) for the mining company. These involve decision-making aspects which is a rich source for further research. Various regulatory considerations provide information to guide the aforementioned purpose of the work. In this regard CSR (Corporate Social Responsibility) and GRI (Global Reporting Initiatives) are prominent role players in this group.

Ultimately the environment is the important variable which is what a large part of this research is about. Other variables as far as the mining company is concerned are the stakeholders (e.g., investors) and employees.

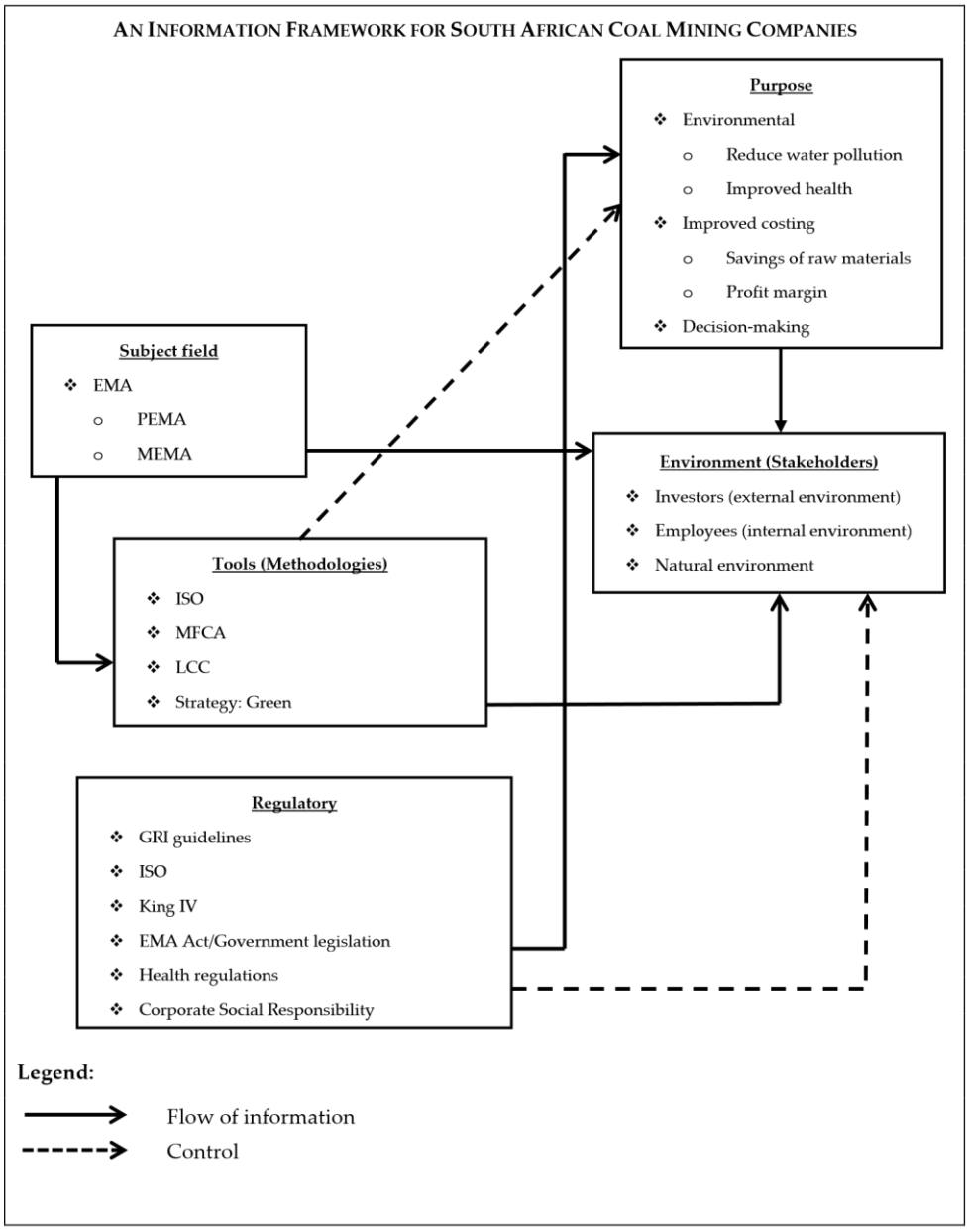

Figure 5. Conceptual information framework for South African coal mining companies.

Source: Synthesised by researchers.

6. CONCLUSIONS AND FUTURE WORK

The coal mining industry offers lucrative business opportunities (profit), but challenges (environmental, health, etc.) as well. Opportunities include, amongst others the value added to a country's GDP. For instance, South Africa generates about 240,300 gigawatt-hours of electricity on an annual basis. A greater portion of the produced electricity is for local consumption whilst about 12,000 gigawatt-hours are sold to neighbouring countries in the Southern African Development Community (SADC) which takes part in the Southern African power pool hence a contribution to the

country's GDP due to revenue generated form export [57,58]. Challenges include environmental impacts such as leakage of chemical substances from mine dumps, contamination of water due to AMD, deformed landscapes and underground fires that are evident in the Blesboklaagte region (Figure 1). Furthermore, it was established that coal mining activities impact on humans by causing diseases such as pneumoconiosis, asthma and hyperpigmentation.

PEMA and MEMA were established as the two branches of EMA. Key variables such as systematic characteristics, governance and institutional engagements, socio-economic conditions, biophysical settings, local variables and SLOs were major issues applicable to the South African coal mining sector and were noted as determinants to the SLO. MFCA and LCC within EMA were established as key tools to enhance efficiency in the production process and to reduce material waste in order to realise profit.

Key determinants of EMA adoption are different across countries, yet similar in some, and these include social structural inspirations and company contextual encouragements; institutional theory, normative- as well as isomorphic; environmental compliance and pressure from law enforcement agencies; whilst the adoption of EMA principles was established as being voluntary in South Africa. It was argued that in a voluntary scenario, ecological degradation may suffer whilst coal mining companies are generating profits and not attending to the resultant environmental consequences.

The literature indicated a gap and a need to develop an information framework necessary for facilitating cost savings of environmental impacts for the coal mining industry in South Africa. A preliminary and conceptual information framework incorporating these aspects was constructed.

Future work in this area may be carried out in a variety issues such as: The conceptual framework has to be enhanced in conjunction with the findings from a qualitative industry survey which the researchers intend to undertake in the near future. Knowledge management principles [59] to strengthen the decision-making component of LCC in the framework have to be embedded. The final framework will be evaluated through a focus group as a follow-up survey.

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APPENDIX G: DATA SATURATION POINT

QUESTION 1: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. EIAs	✓			✓	✓			✓			✓	✓	✓	✓						
2. Specialist studies & research	✓	✓						✓		✓	✓		✓						✓	✓
3. Project designs	✓																			
4. Onsite inspections			✓																	
5. Planning			✓								✓									
6. Legal requirements/cases law		✓			✓		✓	✓							✓		✓			
7. Government requirements						✓			✓		✓		✓							
8. Responsive oriented info							✓													
9. EMPs								✓												
10. Shareholders									✓	✓	✓		✓		✓					
11. Internal audits/monitoring									✓	✓										
12. Cost implications/analysis										✓					✓					
13. Benchmarking/National and international guidelines											✓		✓		✓					

QUESTION 1: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
14. Occupational hygiene and environmental analysis														✓						
15. Control of impacts			✓																	
16. Impact assessments				✓																
17. Modelling (long term)											✓									
18. Complaints from public																✓				
19. Not sure																		✓		

QUESTION 2: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
20. Definition of waste	✓								✓											
21. Legal requirements / Legislation	✓	✓		✓				✓			✓	✓	✓			✓		✓		
22. Classification of waste		✓			✓	✓				✓										✓
23. Waste control			✓																	
24. Specialist studies		✓													✓		✓			
25. Communication							✓													
26. Technical information								✓												
27. LEAN principles									✓											

QUESTION 2: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
28. Chemical analysis										✓										
29. Coal grade										✓										
30. Material characterisation											✓									
31. Benchmarking											✓			✓	✓					
32. Sampling											✓									
33. Not sure																			✓	

QUESTION 3: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. Project designs	✓																			
2. Identification of current impacts		✓																		
3. Research studies		✓											✓	✓						
4. Planning/planning data		✓	✓					✓			✓									
5. Execution								✓												
6. Measurement/mitigation		✓																		
7. Quantification/evaluation of impacts		✓	✓									✓								
8. Environmental budgets			✓																	

QUESTION 3: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
9. Impact assessment				✓	✓															
10. Legal requirements					✓															
11. Quantification of liabilities/operational costs					✓				✓						✓	✓				
12. Options for recycling & reusing						✓											✓			
13. Generating zero waste						✓			✓											
14. Dry coal beneficiation						✓														
15. Benchmarking											✓									
16. Operational costs							✓											✓		
17. Communication									✓										✓	
18. Spatial data											✓									
19. New technologies											✓									✓

QUESTION 4: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. Return on investment (ROI)															✓					
2. Current system not efficient				✓				✓				✓			✓	✓				
3. System successful & guided by government regulations						✓														

QUESTION 4: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
4. Integration of environment & management functions	✓																			
5. Water saving strategies	✓																✓			
6. Ongoing rehabilitation	✓																			
7. Environmental budgets are essential			✓																	
8. Continuous improvement for environmental performance				✓																
9. Water liability remains a challenge					✓															
10. Risk management & mitigation				✓	✓															
11. Topsoil shortfall & backlog						✓														
12. Not sure							✓	✓		✓								✓	✓	✓
13. Proper budgeting & procurement procedures							✓													
14. Environmental penalties									✓											
15. Environmental liabilities											✓									
16. Poor cost savings													✓	✓						✓
17. Focus on ROI															✓					

QUESTION 5: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. Not familiar with EMA	✓			✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2. Cost benefit analysis	✓									✓										
3. Identifying cost of impacts	✓	✓																		
4. EMA helps coal mining to be proactive on environmental management issues				✓																
5. Identification of resources & impacts					✓															
6. EMA still at infancy & new concept in South Africa									✓											
7. Will improve Life Cycle Costing (LCC)											✓									
8. Poor																				✓

QUESTION 6: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. Cost implications / expensive	✓	✓					✓													
2. EMA is a tool to manage & control coal mining companies			✓																	

QUESTION 6: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
3. Control of environmental degradation				✓																
4. It is not a legal requirement to implement EMA but voluntary					✓															
5. Not sure						✓							✓			✓	✓	✓	✓	✓
6. Companies focus on bottom line instead of implementing EMA								✓		✓										
7. Governance frameworks (ISO standards)									✓											
8. EMA is at infancy									✓											
9. Lack of awareness & understanding											✓	✓								
10. Penalties only imposed on coal mining companies														✓						
11. No sanctions for non-implementation of EMA/voluntary															✓					

QUESTION 7: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
1. EIA process/EMPs	✓		✓										✓							

QUESTION 7: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
2. Operational cost savings	✓						✓		✓							✓				
3. Use of technology / modern tools		✓													✓					
4. Stakeholder engagement		✓																		
5. Identification of impacts & analysis		✓								✓			✓				✓			
6. Risk management & mitigation		✓	✓											✓						
7. Legislation / government guidelines				✓				✓												
8. Integrate environmental management at planning phase					✓			✓												
9. Appoint competent environmental management staff						✓														
10. Have dedicated environmental management budgets						✓	✓													
11. Sustainable system required						✓														
12. Provision for post-mine closure						✓														

QUESTION 7: Theme	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
13. Companies must follow proper procurement procedures								✓												
14. Move away from tick-box exercise									✓											
15. Scientific studies										✓	✓			✓		✓				
16. Change to LCC											✓									
17. Do not know												✓			✓				✓	✓
18. Cost of rehabilitation into NPV														✓						

APPENDIX H: ETHICS CERTIFICATE

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SCHOOL OF BUSINESS LEADERSHIP
RESEARCH ETHICS REVIEW COMMITTEE (GSBL CRERC)

18 June 2017

Ref #: 2017_SBL_DBL_011_FA
Name of applicant: Mr MM Mbedzi
Student #: 72224134

Dear Mr Mbedzi

Decision: Ethics Approval

Student: Mr MM Mbedzi, mashudu.mbedzi@eskom.co.za, 072 793 3531

Supervisor: Prof HM van der Poll, vdpolhm@unisa.ac.za, 011 652 0251

Project Title: An information framework to facilitate cost savings and mitigate environmental impacts in the coal mining industry.

Qualification: Doctorate in Business Leadership (DBL)

Expiry Date: July 2021

Thank you for applying for research ethics clearance, SBL Research Ethics Review Committee reviewed your application in compliance with the Unisa Policy on Research Ethics.

Outcome of the SBL Research Committee:
Approval is granted for the duration of the Project

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the SBL Research Ethics Review Committee on the 27/06/2017.

The proposed research may now commence with the proviso that:

1) The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2) Any adverse circumstance arising in the undertaking of the research project that is

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relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the SBL Research Ethics Review Committee.

3) An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.
4) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

Kind regards,

Ramphal 25/07/2017

Prof R Ramphal
Chairperson: SBL Research Ethics Committee
011 – 652 0363 or ramphrr@unisa.ac.za

27/7/2017

Dr R Mokate
CEO and Executive Director: Graduate School of Business Leadership
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APPENDIX I: LANGUAGE EDITOR CERTIFICATE

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EDITORIAL CERTIFICATE

11 November 2019

To whom it may concern

This document certifies that the manuscript listed below was proofread and edited for proper English language, grammar, punctuation, spelling, and overall style by The Write Words, a division of Mardi Gras Marketing (Pty) Limited. Neither the research content nor the author's intentions were altered in any way during the editing process.

The Write Words guarantees the quality of English language of this manuscript, provided our editor's changes are accepted, and further changes made to the manuscript are checked by the editor prior to submission.

TITLE

AN INFORMATION FRAMEWORK TO FACILITATE COST SAVINGS AND MITIGATE ENVIRONMENTAL IMPACTS IN THE COALMINING INDUSTRY

AUTHOR

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